SCHOOL OF
CIVIL ENGINEERING

INDIANA
DEPARTMENT OF HIGHWAYS

JOINT HIGHWAY RESEARCH PROJECT

FHWA/IN/JHRP-91/13

Final Report

THE IMPACT OF HIGHWAY SERVICES AND EXPENDITURES ON REGIONAL ECONOMIC DEVELOPMENT

Paul C. Lombard
Kumares C. Sinha
Deborah J. Brown

PURDUE UNIVERSITY

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The Impact of Highway Services and Expenditures on Regional Economic Development

Final Report

TO:	Vincent P. Drnevich, Director Joint Highway Research Project	October 28, 1991 Revised December 11, 1991 Project No.: C-36-64I
FROM:	Kumares C. Sinha, Research Engineer Joint Highway Research Project	File No.: 3-5-9

Attached is the Final Report on the HPR Part I Study titled, "The Impact of Highway Services and Expenditures on Regional Economic Development." This report presents results from a study to determine how highway infrastructure is related to economic development in Indiana. This research was conducted by Paul Lombard under the direction of myself and Prof. Deborah J. Brown of Agricultural Economics.

This report is forwarded for review, comment and acceptance by the INDOT and FHWA as fulfillment of the objectives of the study.

Respectfully submitted,

K. C. Sinha /rrp

K. C. Sinha
Associate Director

KCS/rrp

cc:			
	A. G. Altschaeffl	A. R. Fendrick	G. J. Rorbakken
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	V. P. Drnevich	B. K. Partridge	R. F. Wukasch
		J. A. Ramirez	

The Impact of Highway Services and Expenditures on Regional Economic Development

Final Report

Paul C. Lombard
Graduate Research Assistant

Kumares C. Sinha
Professor of Civil Engineering

Deborah J. Brown
Associate Professor of Agricultural Economics

Joint Highway Research Project

Project No.: C-36-64I

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16. Abstract

This report presents results from a study to determine the relationship between highway infrastructure and economic development in Indiana. Regression models and a computer model was developed to estimate the annual long-term impacts of highway construction on economic growth. Results from an analysis of economic impacts of the construction of 13 four-lane highway sections in Indiana, as well as an analysis of national data concerning industrial location determinants, are also presented.

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Indiana Department of Natural Resources. Prof. Jim Binkley of the Department of Agricultural Economics, and Prof. Tom Kuczek of the Department of Statistics, both at Purdue University, also provided valuable advice concerning statistical analyses.

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CHAPTER 1

INTRODUCTION

In the developing stages of the United States, transportation infrastructure such as railroads opened up vast areas of the country for development. Increased accessibility facilitated the creation of communities, and the transportation of goods and people between communities and to markets. In 1920, the Federal Aid Highway System was created and the modern highway network was initiated that connected cities and regions in the US [Garrison 1989]. The need for a road system of high standard with no level crossings was answered in 1956, when construction of the interstate system was started. This justification for the system was to increase accessibility and mobility for strategic reasons, and to stimulate economic development all over the country.

Currently most of the highway infrastructure in the US is in place. Transportation forms an integral part of the economy. In 1990, almost 19 percent of consumer spending, equal to roughly $800 billion, was on this commodity. It was estimated that 3.5 trillion passenger-miles were undertaken and 3.4 trillion ton-miles of freight were transported in 1990 [USDOT 1990]. The non-military capital stock, of which highway

infrastructure constitutes a major part, amounted to a total of about $1.9 trillion, or 45 percent of the value of private capital stock in the Unites States in 1987 [Munnell 1990a]. The emphasis has now moved largely to the declining condition of infrastructure, which can be attributed to a decrease in infrastructure expenditures. Spending on public infrastructure has decreased from being 2.3 percent of Gross National Product in 1964 to 1.7 percent in 1987 [Fox and Smith 1990]. Highway expenditures constituted the majority of infrastructure expenditures, and declined from 57 percent of total expenditures in 1964 to 39 percent in 1987. Another disturbing fact is that the infrastructure expenditure in Indiana has been only 1.5 percent of Gross State Product over this time period, which was the lowest in all states of the nation.

In this regard, one of the key areas addressed by the U.S. Department of Transportation in its policy outlines for the 1990s dealt with the maintenance and improvement of the U.S. transportation system, which was noted to become deficient and obsolete [USDOT 1990]. An economist of the Federal Reserve Bank of Chicago has warned that the decline in public capital spending relative to employment and private investment, forces private business to absorb higher costs, and lowers productivity [Aschauer 1988a]. In addition to this, resources to finance extensive highway projects have become very limited. The result has been that the impact of a specific project on an area, with special reference to economic

development, has been stressed in importance in recent years. Decision-makers want to know what the effect of a project will be on the regional economic development in their county or state in order to justify funding for such a project. In fact, a recent study found that 27 of the state highway departments in the United States take economic development into consideration when doing capital investments [Forkenbrock et al. 1990]. Twenty-four states indicated that they had a special highway program to promote economic development, of which 18 programs were initiated only since 1983. The state of Indiana was not included in any of these two groups.

Figure 1.1 shows the hypothesized effect of the construction of an infrastructure project on a regional or local economy. From the beginning of the construction phase, there are employment opportunities which are created. Improved accessibility is the more long-term effect, and provides for an increase in manufacturing and service employment in an area. This in turn provides a bigger tax base, and increased revenues justify the original construction of the project. A demand for new infrastructure is created by the increasing economic activity, and this closes the circle of infrastructure and economic development interaction.

There are, however, two important considerations. Firstly, there are many factors at play in the economic development of a region, and infrastructure is just one of these factors.

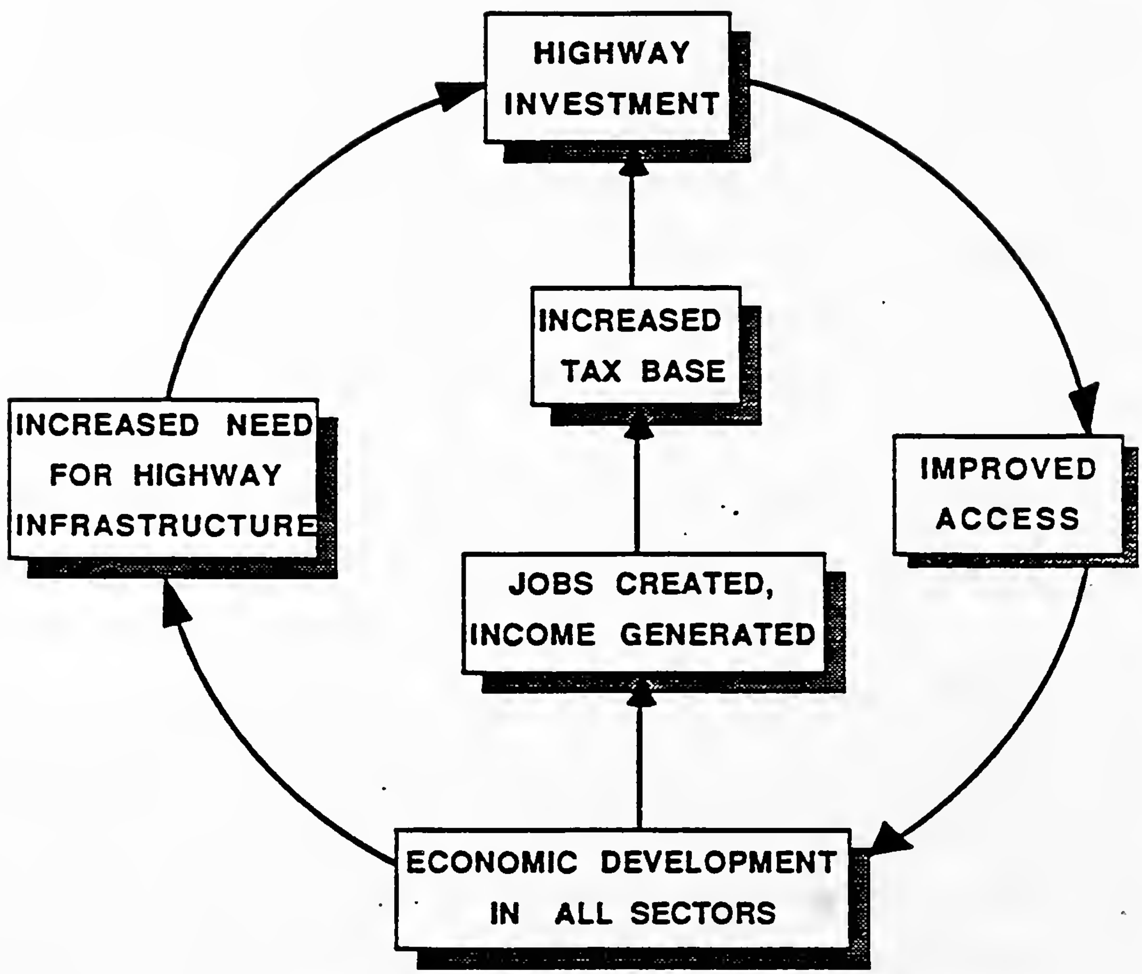


Figure 1.1 The Hypothesized Impact of Highway Infrastructure on Regional Economic Development

Secondly, the extent to which infrastructure, and especially the construction of four-lane highways affect the economic development of a region, is a highly debated issue. Many studies have been done to determine if this effect exists, and how big it is. Results have been varying.

The purpose of this study was to investigate the relationship between highway infrastructure and regional economic development in Indiana. The various aspects of the study are shown in Figure 1.2. Research started with a literature review, to determine from the vast body of literature what underlying aspects were at play, what methodologies had been used in analogous research, and what the findings of other studies were. The main research was divided into three distinct sections, namely:

- an analysis of economic development trends in Indiana and surrounding states over the time period of the study, with emphasis on the highway infrastructure extent and expenditures in each of these states;
- an analysis, at the state-wide level, of the relationship between highways and economic development in Indiana counties over the time period 1980 to 1988, and
- an analysis of the economic development impact of the construction of nine four-lane highway sections throughout the state of Indiana.

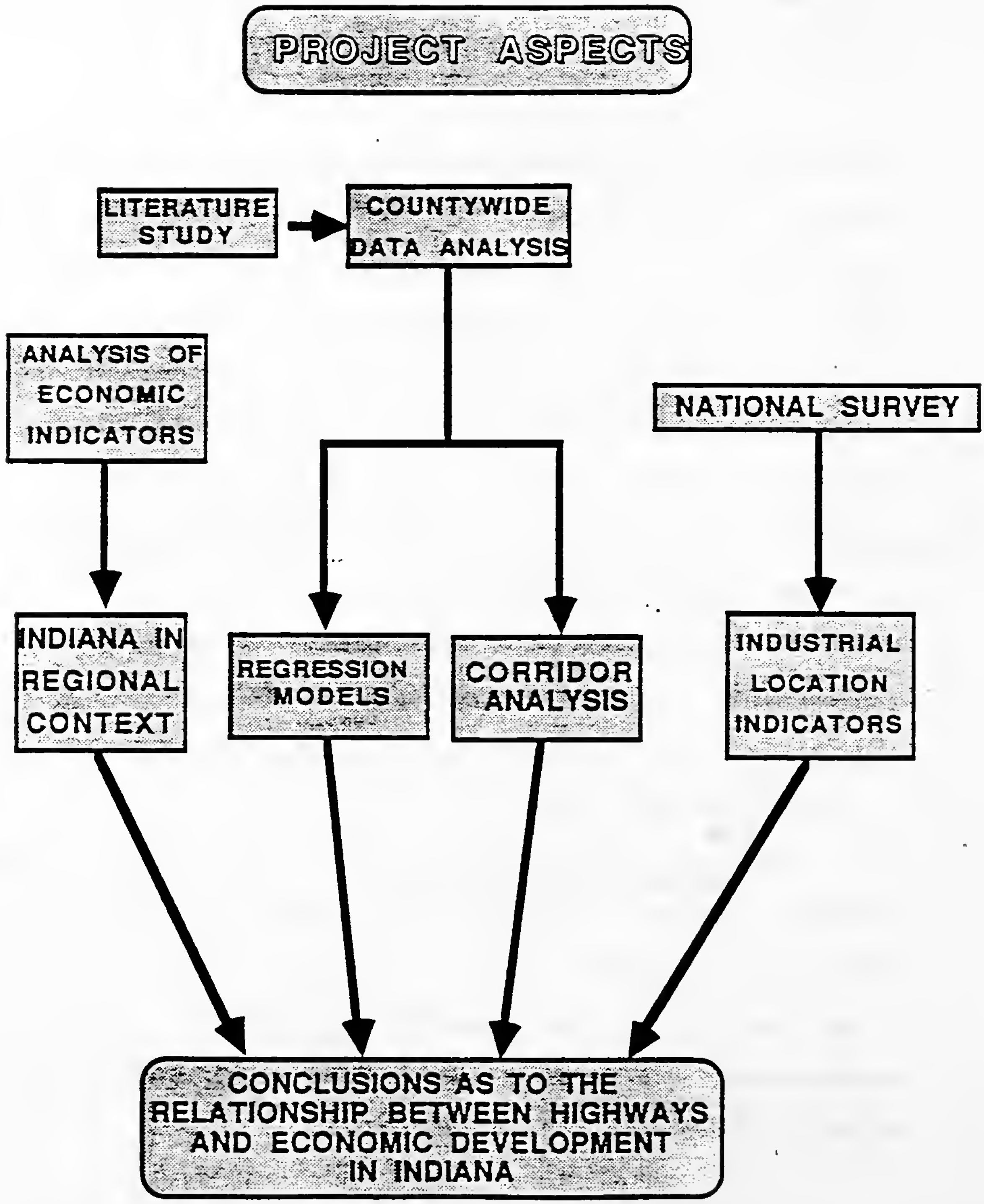


Figure 1.2 Sequence of Project Aspects

In addition to the above-mentioned supply-oriented research, the demand side of highway infrastructure was also investigated, by analyzing data from the US Department of Commerce concerning industrial location determinants [USDOC 1973]. This analysis was directed at investigating the importance of highways relative to other determinants at the national level, and to apply the results to Indiana. Finally, some conclusions were drawn as to the relationship between highway infrastructure and economic development, with specific reference to the state of Indiana.

CHAPTER 2
LITERATURE REVIEW

The role of highway infrastructure in the economy of the United States, from national level to local level, has long been the topic of many studies. Many researchers, and recently policy-makers, have been interested in the relationship between highways and economic development during the past few decades.

In general, there is agreement that infrastructure such as highways, airports, and electricity supply are linked without doubt to economic activity. The effect that highways have on the economy in a locality is however less clear, as infrastructure expenditures may or may not cause economic development in a specific location.

Due to the immense number of studies that have been undertaken on this subject, and methodologies that were used to investigate the economic impacts of various factors including highways, the literature review on the subject was approached systematically. Firstly, some basic and underlying concepts of economic development will be discussed. The role of infrastructure and specifically highways in the economy, as

investigated by some recent studies, will also be discussed. A summary of methodologies that are typically used to determine economic impacts of factors including infrastructure projects will be given, and a discussion of recent and similar projects that were undertaken in other states will follow. Some quantitative results from different studies will also be presented.

Some Underlying Concepts of Economic Growth or Development

Economic development is defined by some researchers as bringing more business sales, employment, personal income and population growth to a region [Weisbrod and Beckwith 1990]. Some of the other financial impacts of economic development are investments that are made in various types of land development, which in turn cause an increase in property values. Local government revenues and expenditures are also increased by development. John et al. [1988] stated that changes in wage and salary employment are possibly a more direct measure of local economic activity than changes in population or changes in income, although these do not differentiate between high and low income employment, and do not include farmers or self-employed persons.

Other researchers make the argument that economic development is not the creation of jobs, but rather the increase of real income in the aggregate [Forkenbrock et al. 1990]. Economic

development is also defined in terms of production, namely as the increase in total output due to the increase in the supply of labor, capital, or both [Bernardeau and Mudge 1989]. This is in contrast to productivity, which increases when an efficient use is made of the inputs of production. Productivity is most easily measured by labor productivity, or the ratio of output to hours worked, adjusted for inflation [Munnell 1990a].

The following are examples of how economic development was measured in different studies :

- The average annual growth of per capita income per state [Aschauer 1990];
- The total employment density per square mile in the study year in a county, and the manufacturing employment density per square mile in the study year in a county [Nelson 1990];
- The employment and income levels per county over a time period, in different sectors such as manufacturing, retail and all industry [Stephanedes 1990];
- The real increase in income, measured as the net benefit of a transportation project as a result of all benefits minus costs associated with the construction [Forkenbrock 1990];
- Study year manufacturing employment per base year population of central place [Lloyd and Wilkinson 1985];
- Change in total wage and salary employment per county [John et al. 1988].

Location Theory

Industry recruitment has traditionally been seen as a state- or community-controlled economic development strategy. Location theory, which basically considers the factors that are important to attract firms to locate in a specific state or county, has a massive body of literature associated with it. Industrial location is seen as a two-stage process, concerned with spatial profit maximization. The first stage occurs when a firm selects a general region for location, and the second when a specific site is chosen [Kriesel and McNamara 1990]. The second stage is where local communities can have an impact on economic development in their region. In a recent study in Georgia, for example, it was found that an exemption of manufacturers from inventory tax had been significant in attracting new industries to certain counties [Kriesel and McNamara 1990]. In a study involving 160 small communities in Pennsylvania [Lloyd and Wilkinson 1985], the level of community activity and awareness were investigated to determine what their effect was on the location and expansion of firms in the manufacturing sector in rural areas. Results provided statistical evidence that a community can have a direct impact on manufacturing growth by taking actions such as developing infrastructure, by seeking assistance from other levels of government, and by promoting solidarity in a community.

Due to structural changes in the US economy over the past few decades, there has been a migration of industries that employ low-skilled and low-wage workers to other countries, and there has been a shift to growth in service employment in the US. There are, however, still opportunities for states or counties to attract manufacturing industry in the US [McNamara 1991]. A total of 5,824 new manufacturing investments were made in the US during 1986 to 1989. Seventy-two percent of these investments were made in four specific regions of the US, one of which was the East-North Central Region that includes Indiana. It is also a fact that firms look for a series of factors to be present when investigating a specific region for location. Rural communities, because of their nature, are at a disadvantage when compared to urban counties, but can make certain improvements to attract industry. A series of factors that, according to the literature, are important to firms when making locational decisions were listed by McNamara [1991]:

- the agglomeration of population and economic activity;
- labor availability and quality;
- air and highway transportation;
- industrial site quality, and
- local public services.

Throughout the location theory literature, it is evident that highway infrastructure is one of the prime factors considered by industrialists making locational decisions. Industries that are especially sensitive to freight transportation are those

that manufacture and use low-value, high-bulk materials. The value and weight of goods that are transported are key elements in determining transportation costs [Sinha et al. 1983]. Forkenbrock warned, however, that better highway infrastructure is only one of many factors that are important in attracting industry, and to invest only in highways, but neglect other factors, will not foster economic growth [Forkenbrock et al. 1990]. This fact was confirmed in other studies, e.g. Smith and Fox [1990]. Locational economic growth appears to be the result of broad-based economic development efforts and activities [John et al. 1988].

Any economy, especially at the local level, usually has an export and non-export sector, as well as basic and service industries.

Export and Non-Export Sector

In any local economy, there exists an interdependence between the export sector, and the non-export sector. Export activities are economic enterprises that produce goods and services that are to be sold outside the local economy, and thus brings income to an area. This provides opportunity for growth. Typical export activities are auto manufacturing, agriculture, mining, and tourism. The non-export sector sells goods and services to consumers within the local economy. It does not bring new income into an area, but circulates it

within. Typical non-export industries are retail grocery stores and auto repair services.

Basic and Service Industries

Another distinction, between basic and service industries, can be made. Typical basic industries are those industries that manufacture products, and typical service industries are financial institutions, insurance companies, and medical services. Although basic industries are normally associated with the export sector of a local economy, service industries can belong to either the export or the non-export sectors, or both.

Economic Impacts of Highway Infrastructure

When an infrastructure project and specifically a highway project is undertaken, there are a few economic impacts that are generated. These impacts can be described as direct and indirect impacts [Allen et al. 1987, Weisbrod and Beckwith 1990]. Direct impacts are the direct effects of a project on the local economy. For example, during the construction years, a project provides employment for people in an area, and thus increases the personal income per capita for a locality in the short term. Industries that supply construction materials also have an increase in income. The construction of a new manufacturing industry will have the same effect as a highway

project, with the difference that the impact will not terminate at the end of the construction period, but carry on as the industry starts production and employs local workers.

Another direct impact of a new highway facility in the long-term is the decrease in road user costs that are associated with improved roads. Travel time savings, operating cost savings, accident cost savings, as well as reduction in discomfort for road users are benefits which can be quantified to a certain extent to justify expenditures on a new facility.

Indirect impacts of infrastructure projects are those impacts that result indirectly from the construction of a new facility, and which can influence the economic development of an area. These are sometimes called secondary effects [Politano and Roadifer 1988]. The increase in capital in a local economy has a multiplier effect, as personal income and capital from the sale of construction materials is spent again and again. This latter element is sometimes further defined as the induced effects of a project [Allen et al. 1987], which affect change in household consumption and production. Improved accessibility of a region may attract manufacturing industries to locate in an area, as the cost of transportation of raw materials and manufactured goods will be decreased. Tourism to an area may also be influenced, with an increase in local service industries to meet expanded demands. The indirect impacts from a project are generally of a more long-

term nature than direct impacts. Hartgen et al. [1990] called these non-user indirect and induced benefits, specified as increases in land values, increases in the competitive position of a location, and improvements in the quality of life. It should be noted, however, that methodologies to determine and quantify these impacts are not well-developed.

Research in recent years has suggested that infrastructure, and specifically highways, affect the economy more than expected. An economist of the Federal Reserve Bank of Chicago had suggested that infrastructure can increase the productivity of private capital and create expenditures in the private sector on new plant and equipment. By using regression analysis and nation-wide data from 1953 to 1985, he showed that the rate of return to private capital was positively related to the public capital stock [Aschauer 1988b]. He furthermore stated that the recent decline in public relative to private capital stock explained some of the decline in the profit rate in the United States. Also, with annual data from 1949 to 1985, he produced evidence that "core" infrastructure such as highways and mass transit should possess the greatest explanatory power for productivity changes over the time period [Aschauer 1989a]. Ashchauer made the suggestion that public investment in basic infrastructure allows the private sector to distribute goods and services through markets, both in the United States and abroad, and increases private

investment by raising the profitability of private plant and equipment.

Aschauer also addressed the question of whether public capital "crowds out" private capital. "Crowding out" can be defined as the increased spending in one category, displacing spending in another, in amounts smaller, greater or equal to the original spending [Bernardeau and Mudge 1989]. In a study in 1989, Aschauer provided empirical evidence that the net effect of an increase in public infrastructure expenditures would probably cause a small decrease in private investment, overall creating an increase in the national investment [Aschauer 1989b]. This effect has two components, namely reducing private investment because the private sector uses public capital instead of expanding private capacity, and increasing it by aiding in the production and distribution of goods and services. Aschauer also investigated the role of transportation in the US economy, and found that a higher level and quality of highways raise the marginal productivity of capital [Aschauer 1990]. This study will be discussed in more detail later in this literature review.

Another well-quoted researcher on this topic, from the Federal Reserve Bank of Boston, did a follow-up study on Aschauer's work [Munnell 1990a]. She investigated whether productivity changes in public capital over the past few decades, in combination with private capital and labor growth, were

responsible for the slowdown in productivity growth in the United States. Results indicated that of the 1.4 percentage point decline in labor productivity growth between 1969 to 1987 as compared to 1948 to 1969, 1.1 percent can be attributed to the decline in the public capital-labor ratio growth rate. The author concluded that the decline in public infrastructure growth has caused this drop in labor productivity, and advised that the US should construct and maintain its infrastructure more extensively. In analogous research, Munnell investigated state-by-state capital data over 19 years, for each of the 48 states in the continental United States [Munnell 1990b]. This study confirmed the positive effect that public capital had on private sector output, investment and employment, with the same marginal product for private and public capital. The author cautioned that spending on capital stock such as highway infrastructure should not be blindly approved, but aspects such as safety hazards removal and improving the quality of life could produce greater productivity and growth.

This cautionary note again iterates that the degree to which infrastructure expenditures can affect economic development is less clear, and can differ from location to location. Fox and Smith concluded that although communities can get benefits from exploring new ways to deliver infrastructure services, infrastructure can not be expected to stimulate the economy of all communities [Fox and Smith 1990].

Due to the high capital investment involved when highways are constructed, the location and size of facilities can make a significant difference to the total cost of a project. In states or regions where the economy is stagnating, highways have traditionally been regarded as a way of stimulating economic development. In a study early in the 80s [Briggs 1981], the nationwide impacts of interstate highways on rural areas were investigated, between 1950 and 1975, in all 48 contiguous states. It was concluded that although on average interstate presence implied a higher employment and migration change in rural counties all over the US, it is no guarantee of economic development. Briggs also argued that the absence of an interstate highway in a county does not necessarily limit development, and the effect of interstates is probably not as localized as expected. Several other factors proved to be more significant in determining economic development in non-metropolitan areas, such as the industrial base and environmental amenities.

In another study [Mills 1981], the hypothesis that beltways in metropolitan areas encourage people and jobs to leave central cities was investigated. Twenty-four sample cities with and without beltways were included in the study. The results showed that beltways had no significant effect on central city vitality, or the suburbanization of people and jobs. Factors such as land-use regulation, property taxes and mortgage policies did, however, prove to be more significant. Mills

the conclusion that beltways, and probably transportation facilities overall, are only one of several factors that affect urban development patterns.

An analogous but more localized study in Pennsylvania addressed the question of what the effects would be of realigning I-78 in Allentown to bypass the city [Mahady and Tsitsos 1981]. Local officials were concerned that needed travel improvements, which would be accommodated by this project, would damage the local central city economy by encouraging suburban development and decrease the city's tax base. It was concluded that trends in place before the project would prevail rather than be influenced by it, and that with adequate commitment from the private and public sector to invest in the central city, negative economic trends would be ameliorated.

In summary, the following conclusions can be made from this wide variety of studies :

- The impacts of highway infrastructure on the economy seem to extend beyond the obvious benefits derived from less congestion, improved safety, and employment increases generated by highway projects and better accessibility. On an aggregate scale at least, it affects private sector investment and labor productivity overall.
- Traditional or intuitive beliefs about the role of highways in economic development can be misleading, due to the fact

that highway impacts can vary significantly by location and study area, and because many other factors can also affect economic vitality. While highway infrastructure appears to be an important factor in economic development, it is not the only determinant that affects growth.

Typical Analysis Methodologies

A large number of studies have been done to determine economic impacts, and a variety of methodologies have been developed to do this. The most common and widely used methodologies will now be discussed, and the results pertaining to highway infrastructure, as found in specific studies, will be briefly reviewed.

Input-Output Analysis

Input-output models, or interindustry models, were conceived by Wassily Leontief in 1936, when a model of the American economy was developed [Izard 1960]. In an input-output model, an economy is divided into various industry or business sectors, and the model provides a more detailed picture of a regional economy by describing the linkages between industries, as well as the direct and indirect responses of an economy to changes in external demand [Plaut and Pluta 1983]. These models permit the measurement of impacts in large industrial or sectoral detail, but is more adaptable to the

analysis of projects than policies [TRB 1982]. The input-output coefficients are costly to develop, as a lot of data are required to compile these. Much of the supporting data are available only at 10-year intervals, with lags of two to three years, which makes it difficult to obtain estimates based on reasonably current information. The input-output relationship which is predicted may not stay the same over a period of time, and it is therefore more useful for predicting short-term effects than for long-term forecasting [Faas 1980]. Input-output models also do not account for changes in industrial location and people as a result of highway improvement [C.C. Harris 1974]. Some of the input-output models that had been used in or developed for economic studies are discussed below.

The Regional Econometric Models Inc. Model (REMI) was originally developed under funding from the National Cooperative Highway Research Program, and was used in over 20 states in the US for various purposes [TRB 1982]. It evaluates the regional economic impacts of policies affecting transportation, energy, and environmental issues. The model incorporates components of input-output models and econometric models, and has capabilities for policy testing. It consists of two parts, namely an Input-Output Model (IOM), and a Forecasting and Policy Simulation Model (FPSM). The IOM has a capability of examining 500 sectors, and can determine short-term economic impacts on a state, due to the construction of

facilities, as well as new employment generated due to the transportation improvement. The FPSM is a model for policy simulation and forecasting in 29 sectors, with capabilities to determine the long-term effects of changes in transportation or other costs.

This model was used in the Southwest Indiana Highway Feasibility Study. The model was calibrated on a 15-year history of county economic patterns and measures of labor, energy, transportation and other costs. It regards highway construction impacts separately from longer-term economic impacts and forecasts employment and personal income by Standard Industrial Code (SIC), as well as population and Gross Regional Product for each area. The study dealt with highway improvements in two parallel corridors. Several alternatives were considered in each corridor, and results indicated that in all cases the overall relationships of benefits to costs were too low to justify construction or upgrading of the highway, as applicable [Seskin 1990].

Another application of the REMI model was the state-wide Wisconsin Forecasting and Simulation Model, used in a study to determine the effects of the construction of a four-lane highway across North-Central Wisconsin. The model, using an input-output approach, provided information on business output and employment for 490 individual sectors and 94 occupational sectors [Weisbrod and Beckwith 1990].

The Regional Input-Output Modeling System (RIMS II) is a static input-output model developed originally by the Bureau of Economic Analysis (BEA) as the RIMS model (Regional Industrial Multiplier System) in the 1970s, and was recently enhanced to the RIMS II model [Beemiller 1990]. In this model, direct requirements coefficients are derived from the BEA input-output tables for 500 industries in the US, and from county wage and salary data for the BEA's 4-digit Standard Industrial Classification (SIC) tables. The latter data are used to adjust for a region's economic structure, and regional multipliers for individual employment, earnings and output are estimated. This model was recently used to determine the economic impacts of an industrial plant in Virginia. In essence, this model gives a static presentation of the economy in a region in terms of regional purchase coefficients [Seskin 1990]. This model may experience difficulty in presenting how a change in transportation costs, due to construction of highway infrastructure, will affect the performance of an industry or an economy.

The Regional Economic Impact Model for Highway Systems (REIHMS) [Politano and Roadifer 1988] is an input-output model which can be used to determine direct highway and other benefits at a regional level. The model uses multipliers obtained from the Bureau of Economic Affairs multiplier matrices for 39 industry aggregates, as well as earnings and employment in these industries, and derives individual output,

earnings, and employment impacts. The user cost savings, travel time savings, and accident cost savings as a result of the construction of the facility are also considered. The model was used in a study of 16 counties in the Dallas-Ft. Worth area.

INFORUM [FHWA 1983] is a dynamic, large-scale input-output model which was used in 1983 to determine the impacts of changes in highway performance on the US economy, with emphasis on the consequences of performance deterioration. It is a 200-industry dynamic model, which is linked to the Chase Long-Term Macroeconomic Model. The inputs to the model include estimates of the disposable income of individuals, interest rates, growth of population and labor force, and product prices. The model forecasts for each of the individual industries the total output, the distribution of output to major markets, personal consumption expenditures, and exports and imports of products traded in foreign markets.

The Macroeconomic Transportation Simulation Model (METS) [Politano 1987] is a model developed specifically for highway investment planning, and includes a macroeconomic and a transportation model. The macro-economic model, which uses a total of 93 variables, interacts back and forth with the transportation model to determine the demand, supply, and costs of commodities within the context of distribution to

markets. The METS model has high data and resource requirements due to its complexity.

The Transportation Impact Model (TRIM) [Allen 1987] is based on the 43-commodity input-output table for Ontario, Canada. Initial, indirect, and induced economic effects of a given capital project can be determined by this model.

Most of these input-output models postulate that economic impacts result from an investment in a region's highways, and take into account investment in highway material industries in an area. Some of these models incorporate capabilities to estimate user cost savings, travel time savings, and accident cost savings as a result of the construction of the facility. Each of these models are however complex, and intensive orientation and use of a specific model is needed for adequate exposure to identify its benefits and pitfalls in terms of capabilities and assumptions.

Regression Analysis

Regression analysis has been used in many studies in the past to determine whether infrastructure developments had an effect on the economic development of an area. Also, this methodology has been used in several analyses to determine reasons for the locating of manufacturing industries in specific areas.

In regression analysis, different approaches are used, but usually economic development as measured by manufacturing, service or total employment, is regressed against several variables such as highway mileage, income, and wages. This methodology was used in recent state-wide studies concerning highways and economic development, e.g. a study in Georgia [Nelson 1990]. These studies will be discussed in more detail in the next section. Some applications in studies over the past twenty years, with their brief results, will now be discussed.

In 1972, a time-series study was done in Tennessee [Hileman and Martin 1972] to determine the impact of public investment in water resources on manufacturing employment in the Tennessee Valley Area, with special emphasis on the associated time lags that are involved. In a cross-sectional study in Missouri [Kuehn et al. 1979], regression analysis was used to determine which location factors attract manufacturing industries to small towns in the state. One of the main factors that affected new plant location was good access to a general aviation airport.

A similar study was done in 1980 [Smith et al. 1980] in Kentucky and Tennessee to determine factors attracting manufacturing industry. A total of 565 incorporated non-metropolitan communities were observed for the period of 1970 to 1973. A type of multiple regression analysis method was

used, namely a linear probability model, which identifies the factors or independent variables which will influence the probability that a new industry will locate in a specific community. It also determined how much a specific change in each variable will affect the probability of attracting new industry. Results indicated that having access to an interstate highway would increase a community's chance of attracting a new plant by 6 percent, which was lower than for other factors over which a community has control.

Regression analysis was also used in several studies in other countries. One example was a study to determine the appropriate relationships between highway infrastructure development and regional economy in the central region of Portugal [Do Vallee and Sinha 1984]. Eleven variables were used, including truck-kilometers, employment, population, and percentage of surfaced roads. Various variables were tested as dependent variable for different combinations of independent variables. Six districts in Portugal were used, with data from 3 points in time, namely 1960, 1970, and 1980. The results showed that highway infrastructure has played a significant role in the development of the regional economy in Central Portugal.

Another example is a cross-section study that was done in 1983 [Hine et al. 1983] to determine the relationship between agricultural development and accessibility in the Ashanti

region of Ghana, West Africa. Evidence indicated that villages that were most accessible had more concentration on non-agricultural economic activities, and vice-versa.

A regression model was used to investigate economic growth in the rural parts of the US, by attempting to explain the geographic distribution of economic growth in 7 Farm Belt states from 1979 to 1984 [John et al. 1988]. Results indicated that location close to an interstate highway was not significantly related to economic growth, but that the percentage of workers commuting to other counties was positively related. This could indicate that workers returning from employment in metropolitan areas spend sufficient money in their counties of residence to create growth.

In a recent study in Georgia an ordered, multiple-category logit model was compiled for 158 counties from 1986 to 1988 [Kriesel and McNamara 1990]. This model investigated the probability that a manufacturing plant would be attracted to a community. Specific site quality measures were determined by using a hedonic pricing model, which estimated site quality in terms of a site's attributes. Factors that are controlled by a community, such as effective tax rates, and uncontrolled factors such as the miles of interstate highway in a county, were included as independent variables. The miles of interstate in a county were found to be positively and

significantly associated with decisions of plants to locate there.

Export Base Analysis

Export base models are used for economic base analysis and estimates which industries bring income to communities, and assess information of proposed policies through the use of the multiplier technique [USDOT 1984]. Multipliers are derived which estimate the changes in a local economy caused by increases or decreases in sales in a particular sector of the economy. This method is relatively simple to use, is quicker and less expensive than other methods [Faas 1980], but has only limited short-term applications in smaller economies.

Shift-Share Analysis

Shift-share analysis is another simple economic technique, and shows how industries in a region are related to each other. It also determines how the region's industries compare to the performance of the same industries nationally. This is also a relatively simple and low-cost technique [USDOT 1984].

Causality/Time Precedence Analysis

A study done in Minnesota in 1987 [Stephanedes and Eagle 1987] had the purpose of addressing the causality effect that

highway projects have on economic development. The analysis covered all 87 counties in Minnesota from 1964 to 1982, and used highway expenditure and employment data. Granger-Sims causality tests were used to test causality. These tests are a variety of time-series analysis. Recently, these type of tests have been referred to as time precedence tests, to describe more accurately what the tests actually do.

Other Econometric Methods

Several other techniques and models, which do not specifically fit into the other categories mentioned above, or combine some of the methods already discussed, have been developed to determine economic impacts. Some of these models were used in studies on a national scale, while others were used on state, regional, or local scale.

The Industrial Impact Model was developed at Purdue University in 1979 [Darling 1979] to model the effect of industrial growth on a local economy. The model evaluates development alternatives and the potential impacts of expanding activity in the industrial sector. The purpose of the model was to assist decision-makers at the local level to determine the expected revenues and expenditures attributable to a new manufacturing facility. An economic multiplier is used to determine the augmenting effect in terms of consumption, production, and fiscal linkages. The model is suitable to

determine local impacts in one county, and covers the impacts for the first full year of operation of a new facility, but requires extensive data gathering.

The Chase Long-Term Macroeconomic Model was used by the FHWA in 1983 to analyze on a national scale, the changes in highway expenditures, taxes, production, depreciation, and vehicle-miles of travel that would occur, depending on whether the US government improves the nation's highways or allows deterioration to occur [FHWA 1983]. The model consists of a set of simultaneous equations that were developed to predict approximately 700 variables. Regression equations, identity relations, and assumed variables, were included in the model. Impacts on macroeconomic variables such as Gross National Product (GNP), Consumer Price Index (CPI), disposable personal income, and employment were analyzed. The 1978 service level on the nation's highways was used, and impacts forecasted for 1995. The INFORUM input-output model, discussed earlier, was used to determine the impact of the deterioration of highway performance on particular industry sectors.

The Multiregional, Multi-Industry Forecasting Model was developed at the University of Maryland, but modified for highway evaluation applications to evaluate the regional economic effects of alternative highway systems in 173 economic regions over the US [CC Harris 1974]. It was designed to make long-term regional forecasts subject to reasonable

assumptions, and evaluates alternative government decisions. The model forecasted output by industry in each area for the first year after the base year, and derives other variables such as employment, population, personal income, and government expenditures. Supply and demand data for each year were used to forecast variables in the following year, and repeated recursively for following years. Transportation variables are also included in the form of transport shadow prices. The model can be applied at a smaller level, such as city or county level. It measures only benefits resulting from the transportation of goods, and not from road-user cost savings.

Another methodology was used for a study undertaken in 1987 at the University of Kansas [Clifford et al. 1987], to determine whether a two-lane or a four-lane highway should be built in Southeast Kansas to connect I-35 with I-44. A <u>net present value analysis of costs and benefits</u> was done, investigating the different effects that each of the alternatives would have on population, income, retail sales, and personal income in the area. The increased tax revenues from a four-lane highway over a two-lane highway were also determined. Overall, it was found that it would be more beneficial to construct a four-lane highway than a two-lane road.

A <u>Compressed Longitudinal Analysis</u> [Burkhardt 1983] of historical data was used to determine empirically how the

interaction of various types of highway projects, in different types of communities, create specific socio-economic impacts. Combinations of communities and projects were examined at specific positions in time, corresponding closely to 5 important points in highway development, from preknowledge to stable operation of a facility. Impact and control zones were identified, and a before and after methodology was used to determine quantitatively the differences between the two zones. Based on the hypothesis that highways decrease the neighborhood attractiveness in an area, neighborhood attractiveness indicators such as total population, number of housing units, and median home value, were used to quantify actual versus expected changes before and after highway construction.

To summarize this section, several methodologies have been developed and incorporated in economic impact models, to attempt to simulate the effects that a new development or facility such as new manufacturing industry or an improved highway will have on the economic development of an area.

Input-output analysis seems to be the most commonly used methodology to determine economic impacts. These models can give detailed estimates of how various economic sectors will respond to an external impact, but require detailed data as input, and can be costly and time-consuming to implement. This methodology also uses interindustry relationships from a

national forecast, which is not necessarily applicable to smaller analysis levels. Other limitations, such as outdated data and lag effects are also associated with input-output models. These models also usually have limited capabilities for policy analysis.

Regression analysis has also been used extensively, especially for determining a correlation between manufacturing industry location and site-specific variables. Time-series analysis, cross-sectional analysis, and both of these combined, have been used in several studies. In most of these studies it was found that transportation characteristics, such as proximity to an interstate highway, are highly correlated with the locating of industries in an area. One setback of this methodology is that although it determines correlations between infrastructure investment and economic growth variables, it does not necessarily indicate the causality between the two. These type of models do however require much less data input in general than input-output models, and are less complicated to execute and calibrate.

Two more simple techniques, namely export base analysis and shift-share analysis, have also been used in various studies. The application of these two methods are however limited, and insufficient for determining long-term forecasts. It can be used to indicate if industry transitions are ongoing in a region or not. Granger techniques were also investigated.

These techniques establish temporal precedence, but at the cost of omitting important variables. Several econometric models were also developed. These models incorporate various econometric methods to determine economic impacts.

The conclusions from this part of the literature review show that several methodologies and models, with various levels of complexity and cost, are available for economic impact analyses. An economic analyst should decide which methodology or model suits the requirements of a specific study the best. The level of the study, i.e. national, state, or county level, will determine which techniques and possible existing models can be used, or if a model has to be developed specifically for the study.

Similar Studies in Other States

A recent landmark study was performed to investigate, at the aggregate level, the impact that highways had on the nation's economy over the past few decades, and although it was executed at the national level, it is included here due to its similar objective to other state-wide studies [Aschauer 1990]. The relationship between the highway capacity level and the growth rate of per capita output was investigated. He made the argument that better highway facilities raise the level of transportation services that are available to producers, and

that stimulates private investment. The result is higher growth and income for a particular location.

Data for the contiguous 48 states were compiled for the time period between 1960 and 1985. These data consisted of the real per capita income growth in a state, that was used as the response variable in cross-sectional regression analysis, and several independent variables as follows :

- the 1960 level of per capita income;
- vehicle density, as measured by the total vehicle registrations per mile in a state;
- highway capacity, measured as the road mileage per state area;
- pavement quality, measured as the percentage of deficient mileage (PSR<2.5) in 1982, and
- dummy variables for the various regions in the US.

OLS and WLS (ordinary and weighted least squares) were used to estimate regression parameters and their significance or not. The results showed that in general, states with better highway infrastructure in terms of highway capacity and quality, had higher per capita income growth over the time period. Also, urban density and higher vehicle density were only marginally significant, but urban and rural highway mileage were statistically important for economic growth.

Over the past few years, studies that dealt specifically with the effect of highway investment on economic development at the more disaggregate level, have been undertaken in other states of the US. The following are brief descriptions of these studies, the methodologies that were used, and the results:

The North Carolina Study [Clay et al. 1988; Hartgen et al. 1990]

A general study was undertaken to determine the relative growth in different counties in North Carolina. For the purpose of the study, the 100 counties in the state were classified in the following four groups :

- metropolitan counties,
- other counties with highways of interstate standard,
- recreational or retirement counties, and
- all other counties.

For the period of 1979 to 1987, these four groups of counties were then examined in terms of their population, real property valuations or tax base, agricultural and non-agricultural employment, manufacturing and non-manufacturing employment, travel and tourism, and income and wages.

The results of the study showed that strong growth is situated in metropolitan counties, while the rural counties are lagging behind. The highway expenditures per year per job increase over the study period were the lowest in metropolitan counties. It is important to note that only direct comparisons were made, and no causality between transportation and economic development was investigated.

In the next part of the study, the concentration was on the relationship between transportation access, growth by county, and manufacturing location satisfaction. The 100 counties in the state were classified according to their access in terms of transportation, their economic structure, their manufacturing composition, and their socio-economic characteristics. In order to arrive at this classification, a total of 450 variables were considered. First, factor analysis was used to determine which of the variables are important in each of the categories mentioned above, and cluster analysis was then used to group counties together in terms of the identified variables.

For the analysis of transportation variables, three variable groups were considered, namely :

- internal access (within counties), measured in terms of variables such as total four-lane highway mileage, and percentage of primary roads;

- external access (outside counties), measured in terms of highways, air, train, and bus transportation, and ports, with applicable measures of access in each of these categories;
- fiscal investment, within counties.

In the first two groups, counties were clustered together in five groups varying from poor/very low to excellent/very high internal access. The last group also had five clusters according to functional road classification focus in expenditures.

An important result from this study was that although transportation access influenced economic growth in counties, it was one of many factors which determined this growth. Other factors included taxes, the business climate, available labor, and the education in a county. A survey of 2,500 manufacturing firms in North Carolina is currently being undertaken, and the survey deals with firms' perceptions as to the importance of transportation in terms of the flow of products and materials, and access to labor markets.

The Georgia Study [Nelson, 1990]

This study investigated the association between developmental highways and economic development in Georgia. Economic development was defined as new jobs and higher wages. Cross-sectional analysis with lagged variables was used, employing

ordinary least squares regression, with two separate independent variables namely total and manufacturing employment. The base year of the study was 1980, and the analysis year 1986.

For the purpose of the study, three types of counties were identified, namely urban, rural, and exurban counties. The latter two classifications are used to distinguish between non-urban counties which have close proximity to and interaction with urban areas (exurban counties), and non-urban counties which are outside these areas (rural counties). The dependent variables for measuring highway density, were the federal interstate and local county developmental highway densities in each county for 1986. The results showed that in rural counties there was no significant relationship between total and manufacturing employment, and interstate or developmental highway density. In exurban counties, there was a positive statistical relationship between manufacturing employment and interstate highway density.

Two case studies were also undertaken to investigate economic development along highways through rural and through exurban counties. In the case of rural counties, no increase in development was noted. In the case of exurban counties, there was an increase in employment, showing that highways which link relatively close counties to urban areas, can influence development. The author made the argument that it is more

beneficial in terms of economic development to develop highways which are linking communities roughly 50 miles away from urban areas, than to develop highways through strictly rural areas.

The Iowa Study [Forkenbrock et al. 1990; Baird and Lipsman 1989]

Two studies were undertaken recently in Iowa as part of the Revitalize Iowa's Sound Economy (RISE) program. In 1977, Iowa DOT prioritized the primary road system for improvement. This consisted of a four-level highway stratification of the state highway system. In 1985, the RISE program was started to partly provide local governments with a means to support local economic development initiatives, and partly to stimulate regional development projects by providing funds for new construction, to increase traffic carrying capacities of the state's highways. The purpose of this program was to maximize road investment benefits, and to create opportunities for the growth of the economy. In 1988, a network of commercial and industrial highways (CIN) were identified, including 24 percent of the state's primary road system. The criteria used to establish the CIN include continuity with through routes from adjacent states, total current traffic, and large truck traffic.

In the one study [Forkenbrock et al. 1990], the focus was on special highway projects. It was argued that economic development is not the creation of jobs, but the increase of real income in the aggregate. The least costly way of attracting a specific business should be determined, whether it is the construction of a road, a low interest loan, tax abatement, or some other action. Building highways can reduce transportation costs, but can also increase public expenditure, thereby increasing taxes that can affect development adversely.

The authors also argued that the aggregate real income increase is the appropriate way of measuring economic development. A total of eighteen RISE projects were investigated, and a five-step screening process was developed to evaluate a specific project. The first three dealt with whether a firm would locate at a site without assistance from the RISE program, the fourth with whether a road project would be the most cost-effective way of assisting a firm, and the fifth with the overall benefit-cost analysis of attracting a firm to a site, including all benefits and costs that are involved. This method can be used to evaluate specific road projects to attract specific industries to an area. The net increase or decrease in local income, determined by the transportation cost savings and the associated costs of the project, is the basic criterium for decision-making, to discern between efficient and inefficient projects.

In the second study [Baird and Lipsman 1989], a methodology was developed to determine priorities for primary road corridor development in Iowa. In order to address economic development needs, a regional analysis methodology was developed. The 954 incorporated cities and 99 counties in the state were analyzed according to their economic size and change in economy. In the analysis of cities, four factors were included, namely, population, commercial service, and number of manufacturing and wholesale firms. Six hierarchical levels were developed. In the county analysis, six factors were considered, and four rankings developed. A decision tree was used to assign each county to a level. The city and county data were then combined and highway improvement priorities were developed, to create improved linkages between centers with growth potential.

This study suggested that improvements on the CIN are made in accordance with priority levels, on a corridor-wide basis. The type of improvement is to be determined separately for each corridor.

The Minnesota Study [Stephanedes 1989]

In this comprehensive study in Minnesota, time-series analysis was used. Time-series and cross-sectional data from 1957 to 1982 for all 87 counties in Minnesota were pooled. The effects of highway expenditures on employment, and vice-versa, were

investigated for different groupings of counties and for the state as a whole, in different economic sectors.

Initially, the domination of individual county size as well as national and regional trends were filtered out from the data. Granger-Sims type causality tests were then used to analyze the data. The purpose of using these tests specifically were to distinguish between cause and effect, and to determine an impact over a time period.

The results indicated that highways caused economic development in counties containing the regional centers of Minnesota. In most of the remaining counties, this effect was not significant, except in counties with a tourism base or where improved access to farm markets would be beneficial. A statewide significance of the influence of total employment on highway investment was found, indicating that more state funding was provided for highways in areas with a growing economy.

In summary, these four state-wide studies were typical of economic impact studies, in that a variety of methodologies were used. Some of the common factors that can be identified are the following :

- In urban areas, highways seem to have a significant impact on development. It can be argued that because there are typically better and more extensive highway facilities in

these areas, industries and jobs are concentrated in urban areas, thereby providing a bigger tax base and justification for better highway infrastructure.

- In rural areas, the effect of highway facilities on economic development is not very clear. In counties close to urban areas, there seems to be a significant amount of commuting to urban areas.
- Due to a general decline in manufacturing employment in the US in the past decade, and an increase in service employment, both these factors should be considered in a study of this kind. Specific service industries, such as tourism, can possibly be expected to play an increasing role in economic development in the future.
- Several factors, and not just transportation infrastructure, are responsible for economic development.
- In studies at the disaggregate level, such as within states or regions, counties appear to be the minimum level of analysis, due to data availability. Also, this affects the measure of economic development. At the county level, employment and wage-income data in different industrial sectors are readily available on a year-by-year basis.

Quantitative Findings

Several studies in this literature review provided quantitative results as to the impact of highway

infrastructure and expenditures on economic development. Some of the quantitative results are the following:

- A one percent increase in the public capital stock will increase labor productivity, defined as the inflation-adjusted ratio of output to hours worked, by an average of 0.35 percent [Munnell 1990a].
- A ten percent increase in the highway infrastructure stock in the US will lead to an increase of about 2.3 percent in real private sector output [Attaran and Auclair 1990].
- A one percentage point decrease in pavement quality, measured as the percentage of the highway miles with a Pavement Serviceability Rating of less or equal than 2.5, induces a decrease of 0.009 percentage points in the per capita income in a region per year [Aschauer 1990].
- Highways in the United States, which constitute about 33 percent of the total public infrastructure stock, have been responsible for about 60 percent of the gain in private-sector output that can be linked to public infrastructure [Attaran and Auclair 1990].
- A $1 million expenditure on highways, above the normal expenditure, leads to between 100 and 140 new jobs per year over the next ten years, in regional centers in Minnesota. For the whole state of Minnesota, this figure was 5 to 8 jobs per year [Stephanedes 1989]. An increase in employment of 100 attracted an additional $28,500 in state spending on highways.

- For each job increase in the non-agricultural sector per year in North Carolina between 1974 and 1985, there was a highway construction expenditure of $5,796. This expenditure excluded contract resurfacing and bridge replacement [Clay et al. 1988]. In Minnesota, this figure was projected to be $13,700 over a ten year period, in the typical county [Eagle and Stephanedes 1987].
- Investigation of 16 counties in the Dallas-Fort Worth area indicated that investing $10 million in improving interstate highways, will generate on average 203 jobs, $17.6 million in regional output, and $4.6 million in income that is earned.
- Applications of the REMI model in Indiana, Wisconsin and Massachusetts indicated that significant highway improvements can be expected to result in increases of between 0 and 3 percent in employment and income in a region [Seskin 1990].

It should be noted that these figures were derived in studies performed in specific regions, at the aggregate or disaggregate levels, in a specific time-frame, and with restrictions in some cases. Therefore application of these figures to other states or regions may not be accurate.

CHAPTER 3

INDIANA IN A REGIONAL CONTEXT

When investigating the economic development impact on highway infrastructure in a state such as Indiana, it is sound to make an investigation of the region and state's economy and infrastructure before developing any models to determine such an effect. In order to achieve that, this part of the study was divided into two sections. First, some comparisons were made between Indiana and surrounding states in the region, namely Illinois,Kentucky, Michigan, Ohio, and Wisconsin, and also to the United States as a whole in order to bring the region into perspective to the US in its entirety. Issues pertaining to highway infrastructure and economic development were investigated, over the time period from 1980 to 1988. This nine-year period was selected to concur with the extent of the overall study, in which highway data at the county level were not available before 1980.

In the second section, the Indiana economy was investigated in more detail, to determine in which economic sectors and in what counties the majority of changes in the local economy took place. For the purposes of this study, industries in Standard Industrial Classification (SIC) codes between 1 and

93, as defined by the US Bureau of Economic Analysis, were grouped into 43 SIC groups, to combine industries with similar characteristics together and to simplify analysis and interpretation. The SIC groups, the SIC codes they comprise and brief descriptions are presented in Table 3.1. Manufacturing industries are those industries involved primarily in the manufacturing of goods, with SIC codes between 20 and 39, and identified by SIC groups 5 to 20 in this study. Service industries were classified for the purposes of this study as industries with SIC codes from 41 to 93, and are typically classified in the broader categories of:

- transportation and public utilities (SIC codes 40 to 49);
- wholesale trade (SIC codes 50 to 51);
- retail trade (SIC codes 52 to 59);
- finance, insurance, and real estate (SIC codes 60 to 67);
- services (SIC codes 70 to 89), and
- public administration (SIC codes 91 to 97).

These industries were grouped together in the service industry sector due to their service oriented nature as opposed to manufacturing industries. The total industries sector included the manufacturing and service industry sector, as well as SIC codes 1 to 16, which consist of industries and activities with special characteristics, such as farming or mining. This classification therefore consists of all SIC codes from 1 through 93, or SIC groups 1 through 43 in this study's classification.

Table 3.1 Standard Industrial Classification Group, Code and Description

SIC GROUP	SIC CODES	DESCRIPTION
1	1,2,7,8,9	AGRICULTURE, FORESTRY,FISHING
2	12,13,14	MINING
3	15,17	GENERAL AND SPECIAL CONTRACTING
4	16	HEAVY CONSTRUCTION
5	20	FOOD PRODUCTS
6	22,23	TEXTILE PRODUCTS, CLOTHING
7	24	LUMBER AND WOOD PRODUCTS
8	25	FURNITURE
9	26	PAPER PRODUCTS
10	27	PRINTING AND PUBLISHING
11	28	CHEMICAL PRODUCTS
12	29,30	PETRO,COAL,PLASTIC,RUBBER PRODUCTS
13	31	LEATHER PRODUCTS
14	32	STONE, CLAY, GLASS PRODUCTS
15	33	PRIMARY METAL INDUSTRIES
16	34	FABRICATED METAL PRODUCTS
17	35	INDUSTRIAL MACHINERY
18	36	ELECTRIC, ELECTRONIC EQPMNT
19	37	TRANSPORTATION EQUIPMENT
20	38,39	INSTRUMENTS, MISC. MANUFACTURING
21	41,42,44,45,47	TRUCKING,WAREHOUSING,TRANSPORTATION
22	48	COMMUNICATIONS
23	49	ELECTRIC, GAS, SANITARY SERVICES
24	50	WHOLESALE DURABLE TRADE
25	51	WHOLESALE NON-DURABLE TRADE
26	52	BUILDING MATERIALS, GARDEN SUPPLIES
27	53	GENERAL MERCHANDISE STORES
28	54	FOOD STORES
29	55,75	AUTO DEALERS, REPAIR, PARKING
30	56	APPAREL, ACCESSORY STORES
31	58	EATING AND DRINKING PLACES
32	57,59	FURNITURE AND MISC. RETAIL
33	60 TO 65	FINANCE, INSURANCE, REAL ESTATE
34	70	HOTELS AND LODGING
35	72	PERSONAL SERVICES
36	73	BUSINESS SERVICES
37	76	MISC. REPAIR SERVICES
38	78,79	MOTION PICTURES, AMUSEMENT SERVICES
39	80	HEATH SERVICES
40	81	LEGAL SERVICES
41	82,92,93	EDUCATION, LOCAL & STATE GOV EMPL
42	83	SOCIAL SERVICES
43	86 TO 89	MISC SERVICES

Data for this section were obtained from a variety of sources. Highway data were acquired from the Federal Highway Administration's Highway Statistics publications from 1980 to 1989, and population and land area data from the U.S. Bureau of the Census' City and County Data Book publications for several years. Employment and wage-income data came from mainly two sources, namely :

- County Business Patterns for 1980 and 1988, published by the U.S. Department of Commerce (USDOC), and that were used for state-by-state comparisons, and
- Indiana Department of Employment and Training Services (IDETS) computer tapes for 1980 and 1988, which provided data for county-by-county and sector-by-sector analyses.

Some of the results for employment and wage-income may vary between sections in this chapter, mainly due to the following reasons :

- two different sources were used, namely the USDOC and the IDETS, that follow different ways of collecting data;
- some employment and wage-income figures could not be attributed to specific SIC groups or counties, due to the nature of the classification, and were omitted from the data base, and
- some of the SIC groups with minimal employment in Indiana were deleted for analysis purposes.

Indiana and the Region : 1980 to 1988

Highway Infrastructure Extent and Expenditures

Indiana and its neighboring states are well-served by highways, including interstates. Figure 3.1 shows the 1980 mileage per land area for each of the states in the region, and the US as a whole. The 1980 mileage was selected based on the assumption that the extent of the highway network in the base year would be a factor in determining economic development over the 9 year period. In addition the mileages stayed more or less constant in the 1980s, as most of the highway infrastructure was already in place before 1980. The land area was used to adjust for the size of each state, and also because a state such as Michigan has a large area consisting of lakes.

From Figure 3.1, it is evident that the whole region had both a higher interstate and total road mileage than the US in the aggregate. Indiana had a high interstate mileage density in the region, namely 3.16 miles per 100 square miles, second only to Ohio. The state's total mileage density of 2.54 miles per square mile was also the second highest in the region, again slightly lower than Ohio. These statistics show that Indiana's highway density is more than twice that of the US as a whole, at respectively 0.99 and 1.09 miles per area.

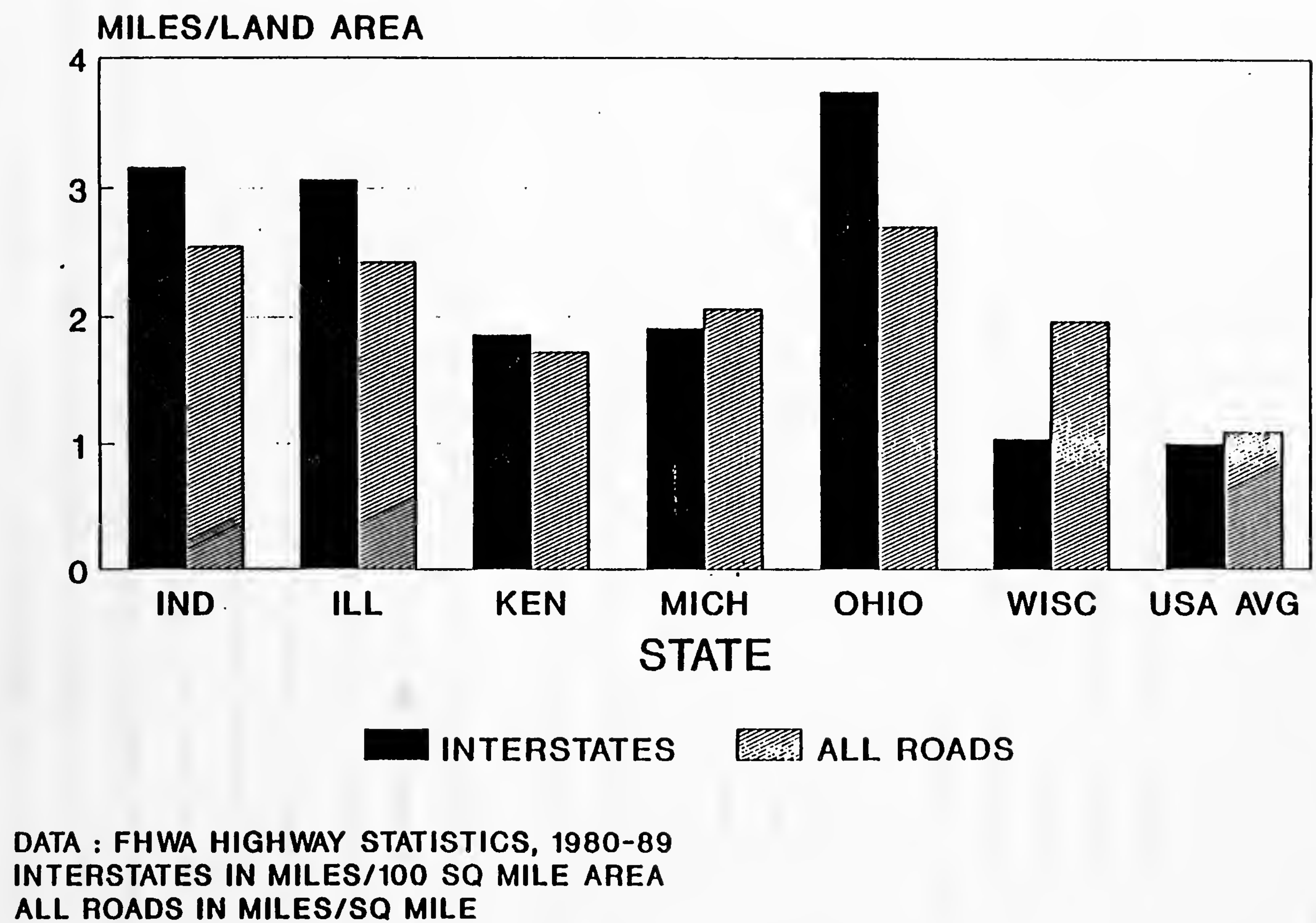
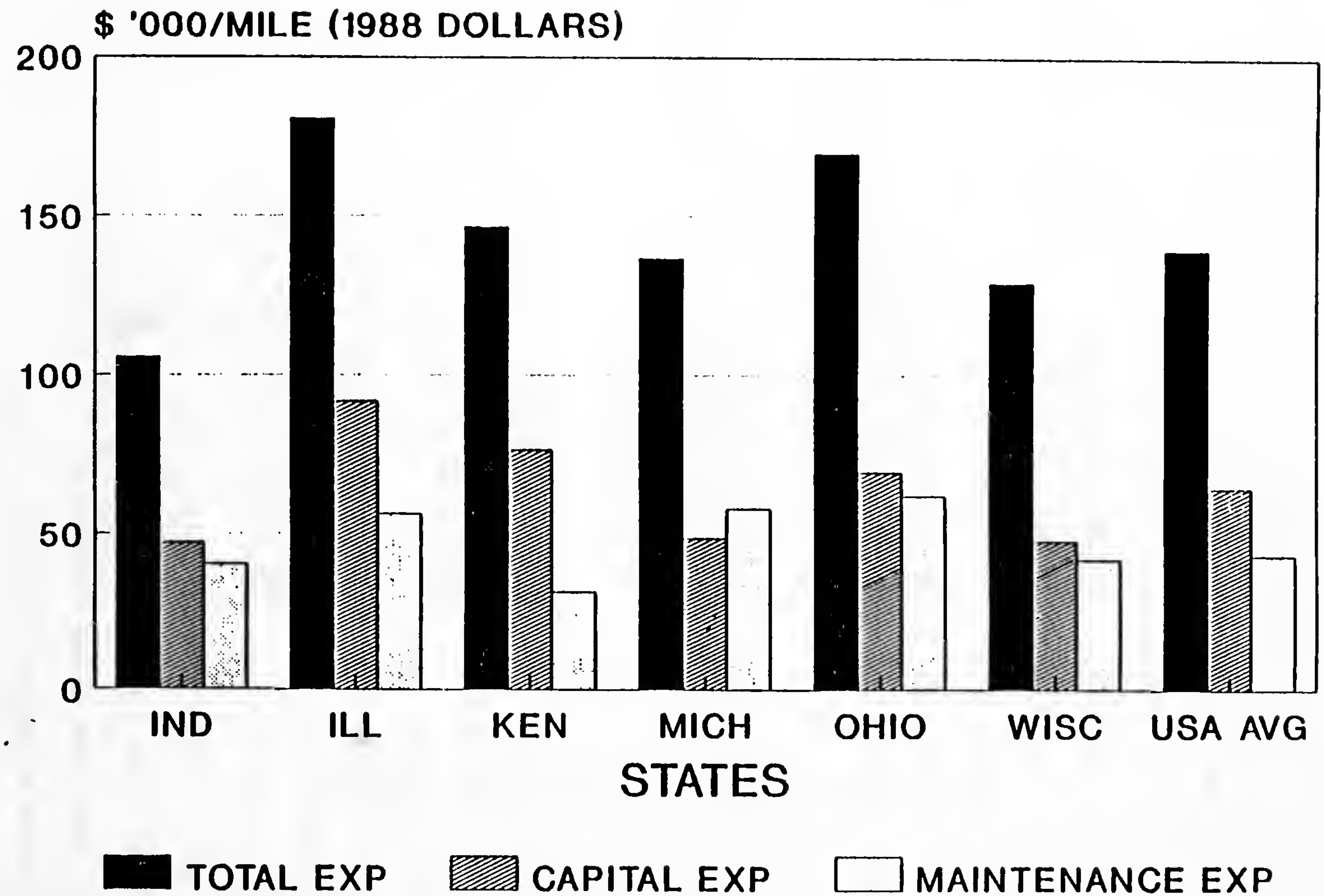


Figure 3.1 Regional Highway Density in 1980

Figure 3.2 addresses the issue of highway expenditures in the region, from 1980 to 1988. All expenditures were divided by the total mileage in the state, to allow for the system extent in different states, and were inflated to 1988 dollar values by using the appropriate highway indices obtained from the Federal Highway Administration's Highway Statistics publications from 1980 to 1989. The disbursements that are shown in this table are presented in three categories, namely capital expenditures, maintenance expenditures, and the total highway expenditure, for all levels of government in a state. It should be noted that in addition to the first two categories, the total payments classification also includes other funds that were disbursed, such as for highway patrol police.

From Figure 3.2 it is clear that Indiana had the lowest capital expenditures on highways for the whole region over the time period, namely about $47,000 per mile, which is significantly lower than the US average of $64,500 per mile. This state's maintenance disbursements were $40,200 per mile, which is also lower than the US average of $43,150 per mile, and again the lowest of all states in the region except for Kentucky. The total highway expenditures, namely $105,800 per mile, was the lowest in the region and well below the US aggregate value of $139,500 per mile.



DATA : FHWA HIGHWAY STATISTICS 1980-89

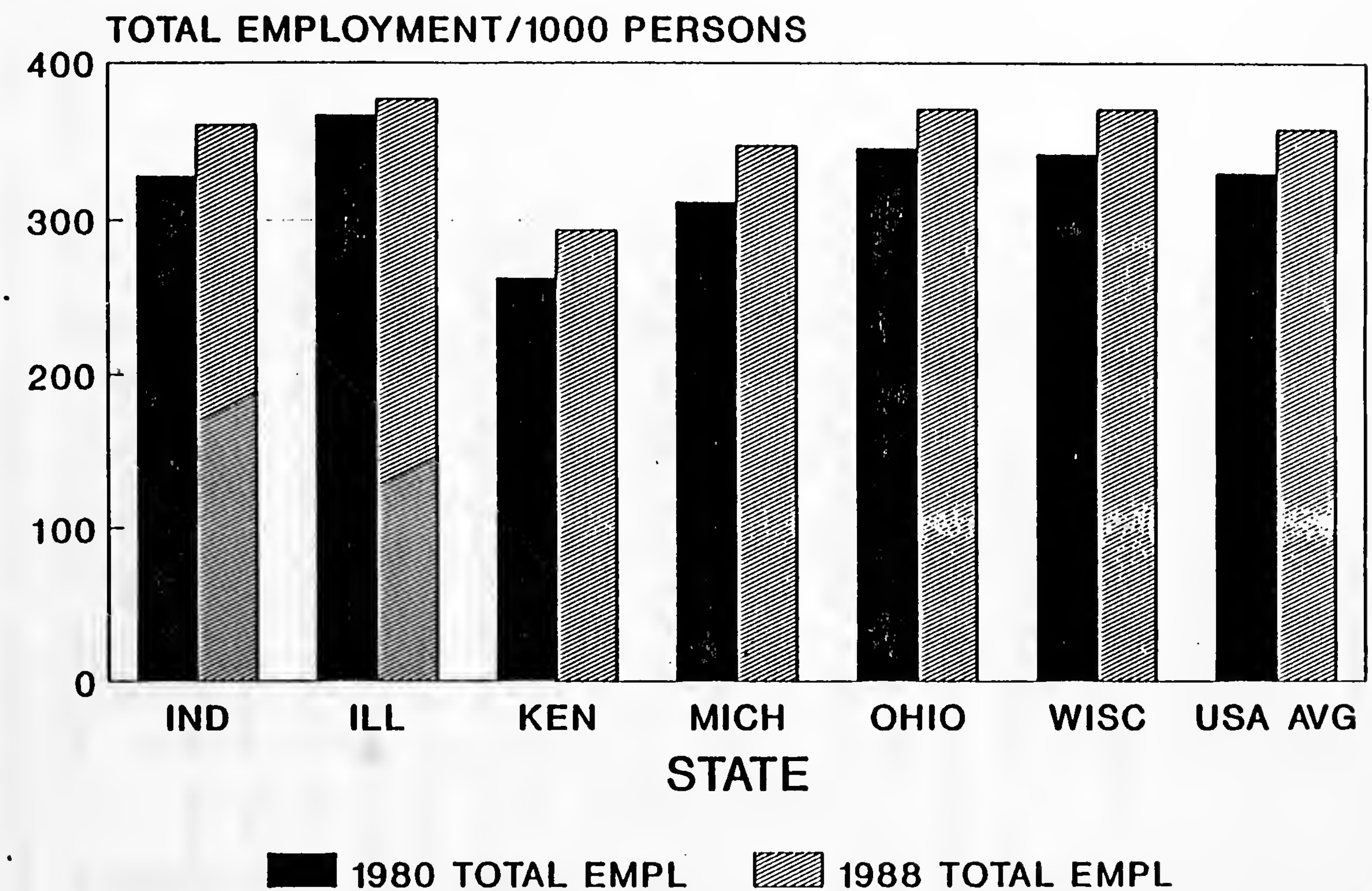
Figure 3.2 Regional Highway Expenditures per Mile from 1980 to 1988

In summary, although Indiana has a more extensive highway network than other states in the region and the US as a whole,it was lagging behind in the maintenance and new construction of that system from 1980 to 1988.

Economic Situation : Employment and Wage-Income

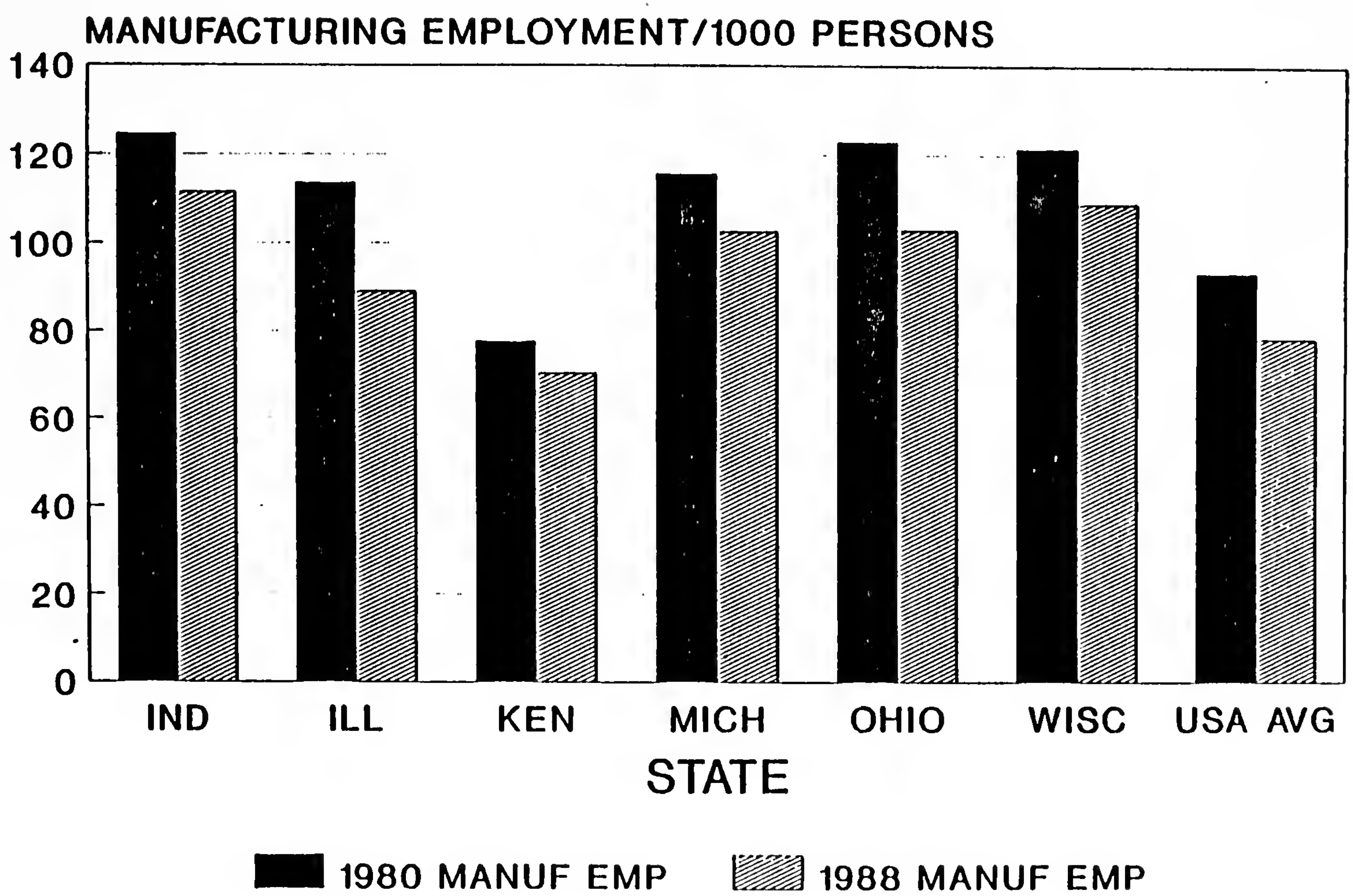
In the following three figures, data are shown concerning the employment trends in the total industry, manufacturing and service sectors in Indiana and surrounding states over the time period from 1980 to 1988. Data were normalized by dividing employment figures by the 1980 and 1988 population as relevant, to allow for the difference in size and number of people living in a state, and employment is to a large extent a function of the number of people residing in a location or region. Figure 3.3 shows the total employment figures in 1980 and 1988, and indicates that Indiana, at 328 persons employed per 1000 population in 1980, was close to the US average of 330, and around the average in the region as well. In 1988 this figure had increased to 360 jobs per 1000 persons, which was slightly higher than the US aggregate of 358, but still at the average of the region.

Figure 3.4 presents comparative employment figures in the manufacturing sector. All states in the region, and in fact the US, experienced a decline in this sector between 1980 and 1988, as evident from the graph. Indiana's employment per 1000



DATA : COUNTY BUSINESS PATTERNS
US BUREAU OF THE CENSUS

Figure 3.3 Regional Total Employment in 1980 and 1988



DATA : COUNTY BUSINESS PATTERNS
US BUREAU OF THE CENSUS

Figure 3.4 Regional Manufacturing Sector Employment in 1980 and 1988

people declined from 125 to 112 from 1980 to 1988, but was still well above the US averages of respectively 93 and 78 at the two points in time. It should be noted that both in 1980 and 1988, Indiana had the highest employment per capita in the region.

In Figure 3.5, service employment figures per capita are given for the industry sectors as specified earlier. Overall, there has been an increase in all states and the aggregate United States from 1980 to 1988. In 1980 Indiana had a service sector employment of 183 jobs per 1,000 persons, which was considerably lower than the US average of 209, and higher than only Kentucky and Michigan in the region. By 1988 this figure has increased to 226 employed persons per 1,000 population, which was still much lower than the US average of 252. In the region Indiana was however slightly ahead of Kentucky, and approximately on the same level as Michigan.

The following three figures give wage-income data per capita in the total industry, manufacturing and service sectors in 1980 and 1988. The 1980 wage-income figures were inflated to 1988 dollars by using the national Consumer Price Indices for the time period. These figures were also normalized for state size by dividing by the relevant population in a specific year. In Figure 3.6 it can be seen that the per capita wage-income in Indiana was only slightly higher than the US average wage-income of $6,585 (1988 dollars), namely $6,603. In the

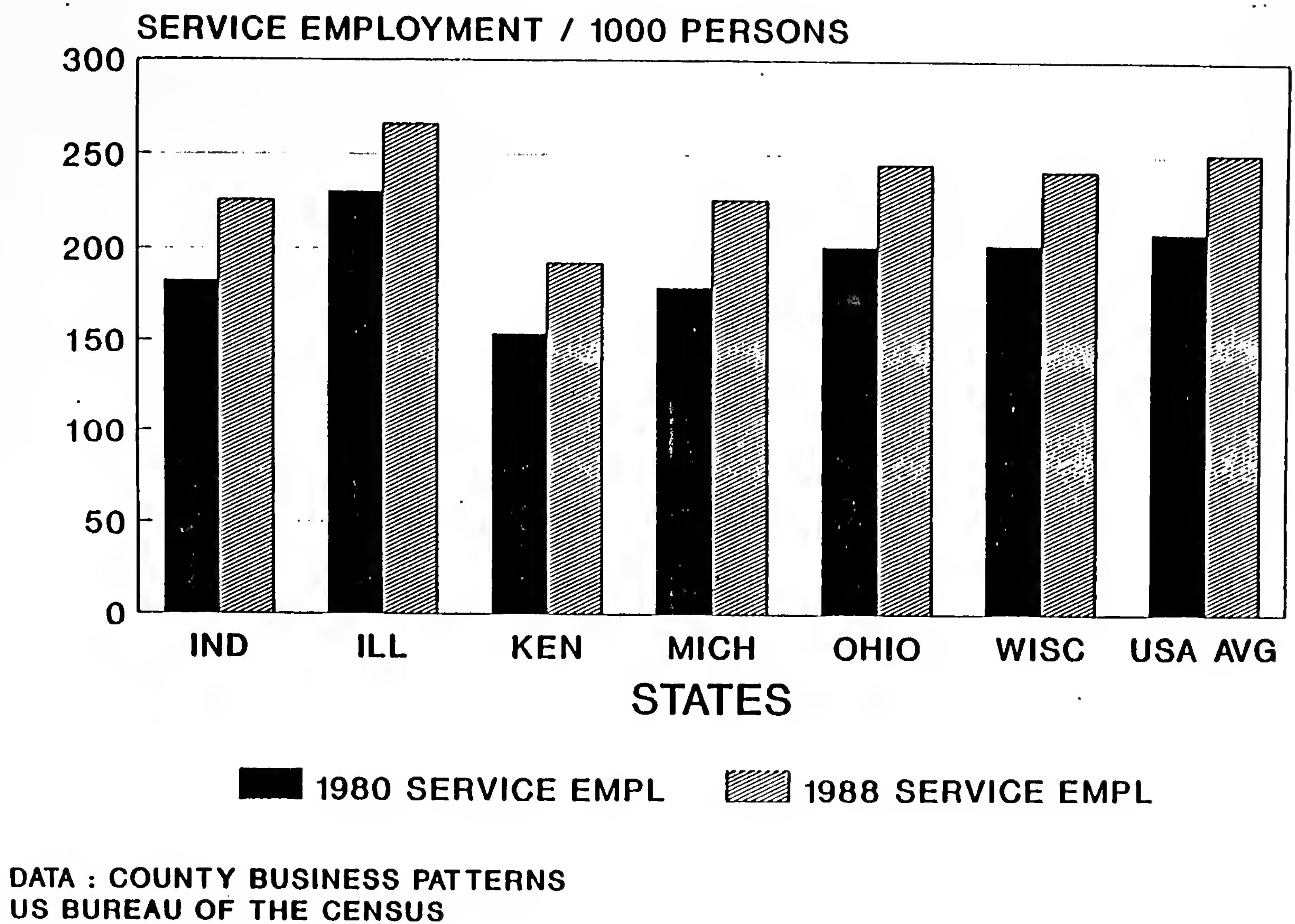
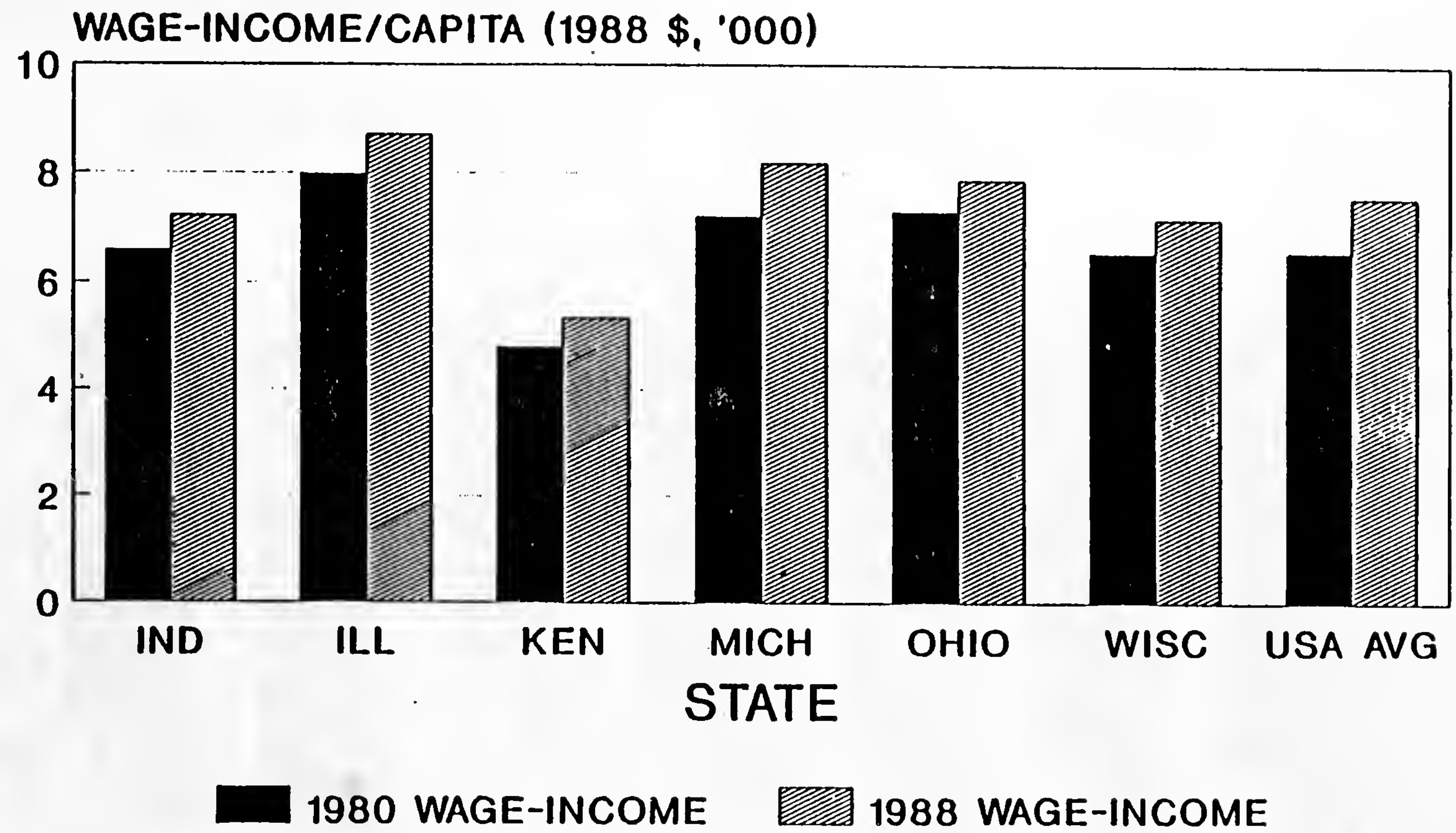


Figure 3.5 Regional Service Sector Employment in 1980 and 1988



DATA : COUNTY BUSINESS PATTERNS
BUREAU OF THE CENSUS

Figure 3.6 Regional Total Wage-Income in 1980 and 1988

region this figure was higher than the wage-income in only Kentucky and Wisconsin. By 1988 the wage-income (in constant dollars) in Indiana had increased to about $7,200, while the US average wage-income per capita had increased to $7,565 per year. Kentucky and Wisconsin's wage-income per capita was still lower than that of Indiana.

The manufacturing industry sector wage-income data are presented in Figure 3.7. Indiana's wage-income per capita in 1980 in this sector, at about $3,270 per year, was higher than the US average of $2,260 and ranked third out of the six states in the region. By 1988 the Indiana figure had decreased to about 3,070, compared to the overall US figure of $2,090 per year in constant dollars. Indiana's regional position had improved, with only Michigan having a higher manufacturing industry wage-income per capita.

In the service industry sector Indiana had an annual wage-income of about $2,800 per person in 1980, notably lower than the US average of $3,650. These figures are presented in Figure 3.8. Indiana's figure was higher than that in Kentucky, but lower than all other states in the region. The 1988 figure increased to about $3,600, with the same ranking as in 1980. The US average wage-income in the service sector had increased significantly to $4,800.

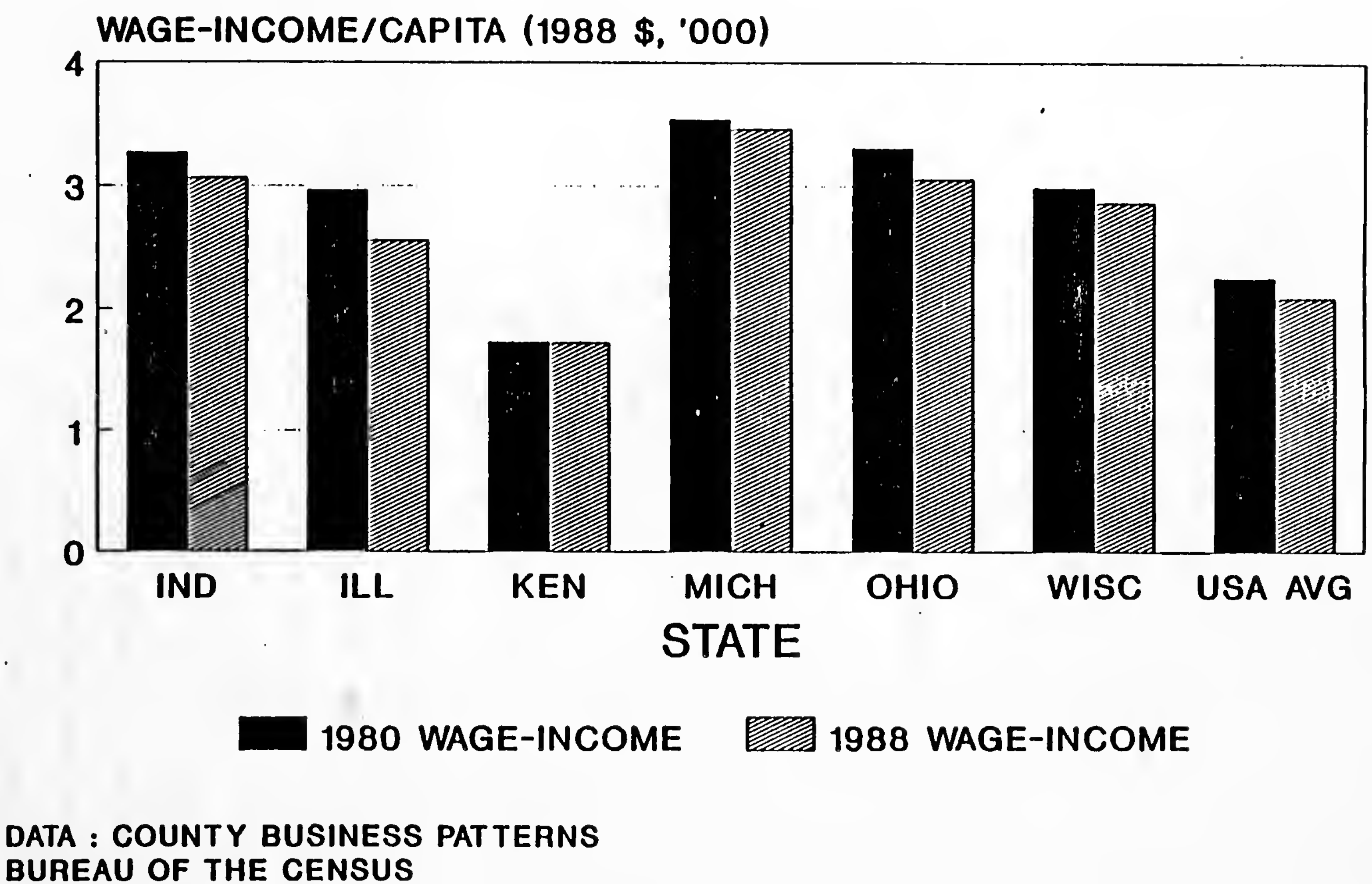
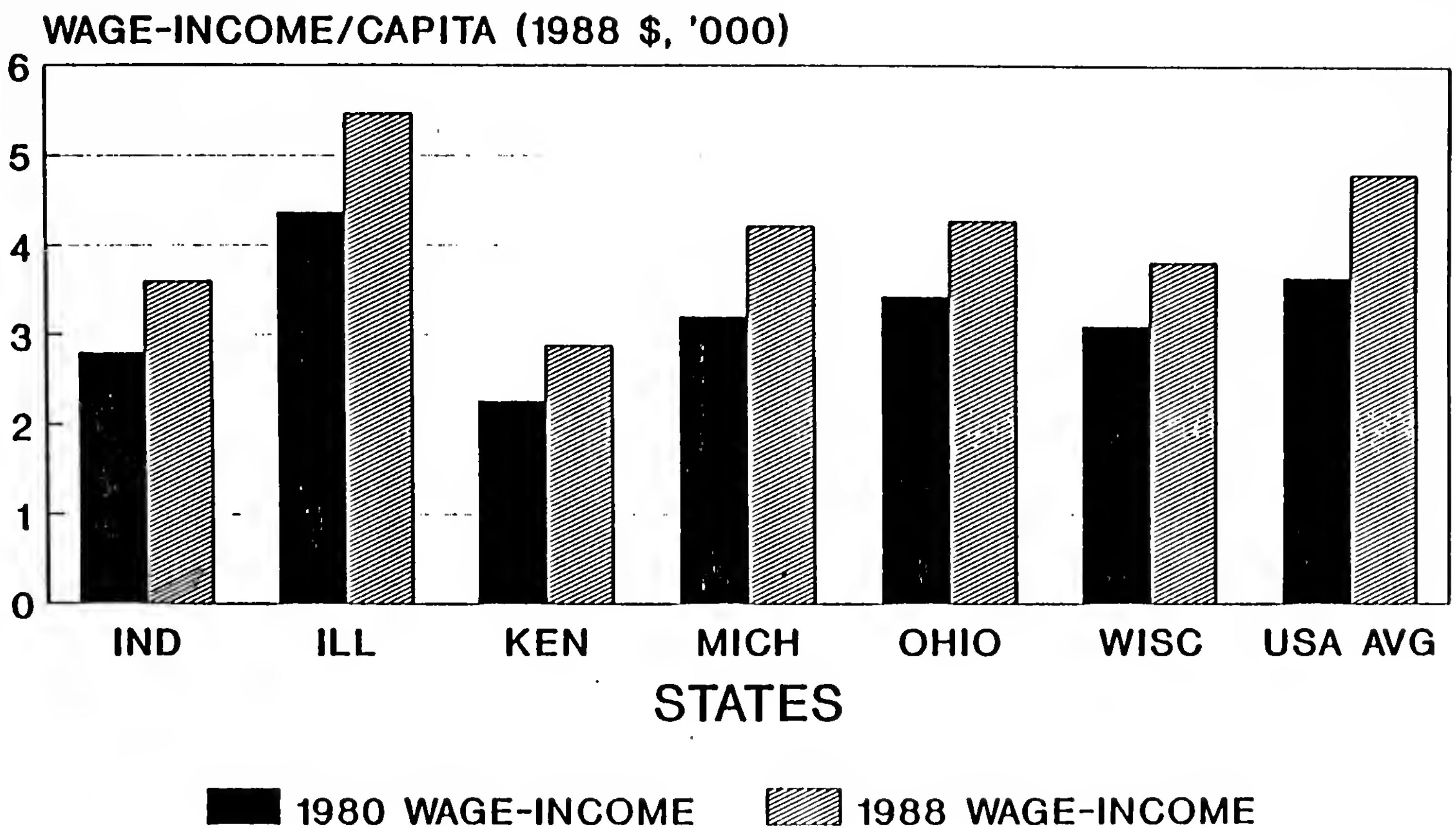


Figure 3.7 Regional Manufacturing Sector Wage-Income in 1980 and 1988

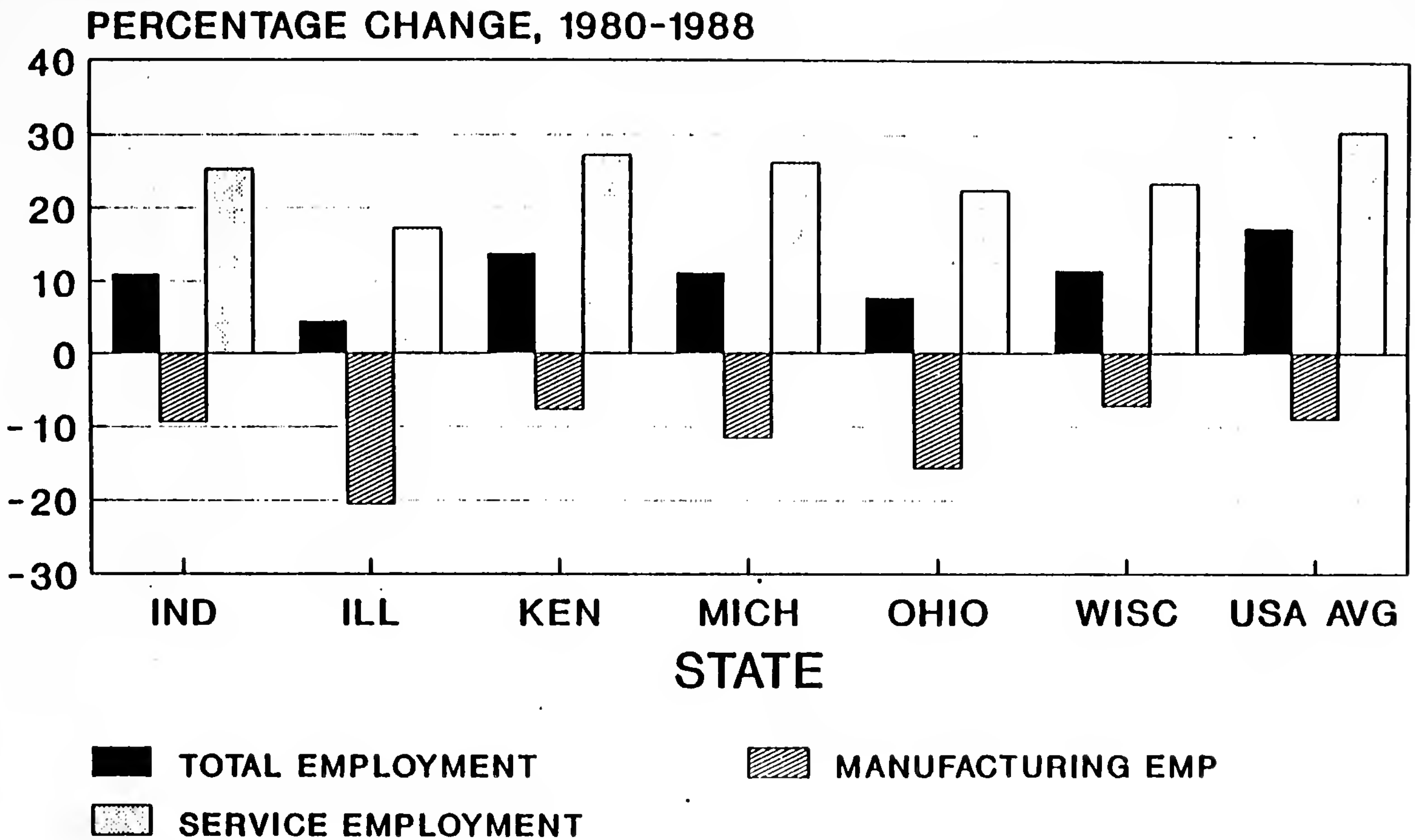


DATA : COUNTY BUSINESS PATTERNS
BUREAU OF THE CENSUS

Figure 3.8 Regional Service Sector Wage-Income in 1980 and 1988

In order to complete the picture of changes in employment and wage-income in the region and the United States between 1980 and 1988, the percentage changes were examined. Figure 3.9 gives the percentage change in employment in all three of the industrial sectors as mentioned. The overall tendencies can be viewed clearly in the graph, namely a decrease in the manufacturing industry sector, and an increase in the service sector, resulting in a net increase in the total industry sector due to the relatively larger size of the service industry sector. For all states in the region, the total employment increase was less than that of the US average of over 17 percent. At an increase of 11 percent, Indiana had a higher increase than both Illinois and Ohio, and about the same as Michigan. In the manufacturing industry sector, the decrease in Indiana of 9.4 percent was less severe than that in Illinois at 20 percent, and Michigan and Ohio at respectively 11.5 and 15.7 percent, but more than the 8.9 percent decrease in the whole of the US. Indiana service industries showed an increase in jobs of about 25 percent, compared to the overall increase in the US of 30.6 percent. This increase was the highest in the region, except for Kentucky and Michigan, but all the states in the region had a lower increase in service industry employment than the country as a whole.

Figure 3.10 presents the changes in wage-income between 1980 and 1988 for the states included in this analysis. Somewhat



DATA : COUNTY BUSINESS PATTERNS

Figure 3.9 Regional Percentage Change in Employment from 1980 to 1988

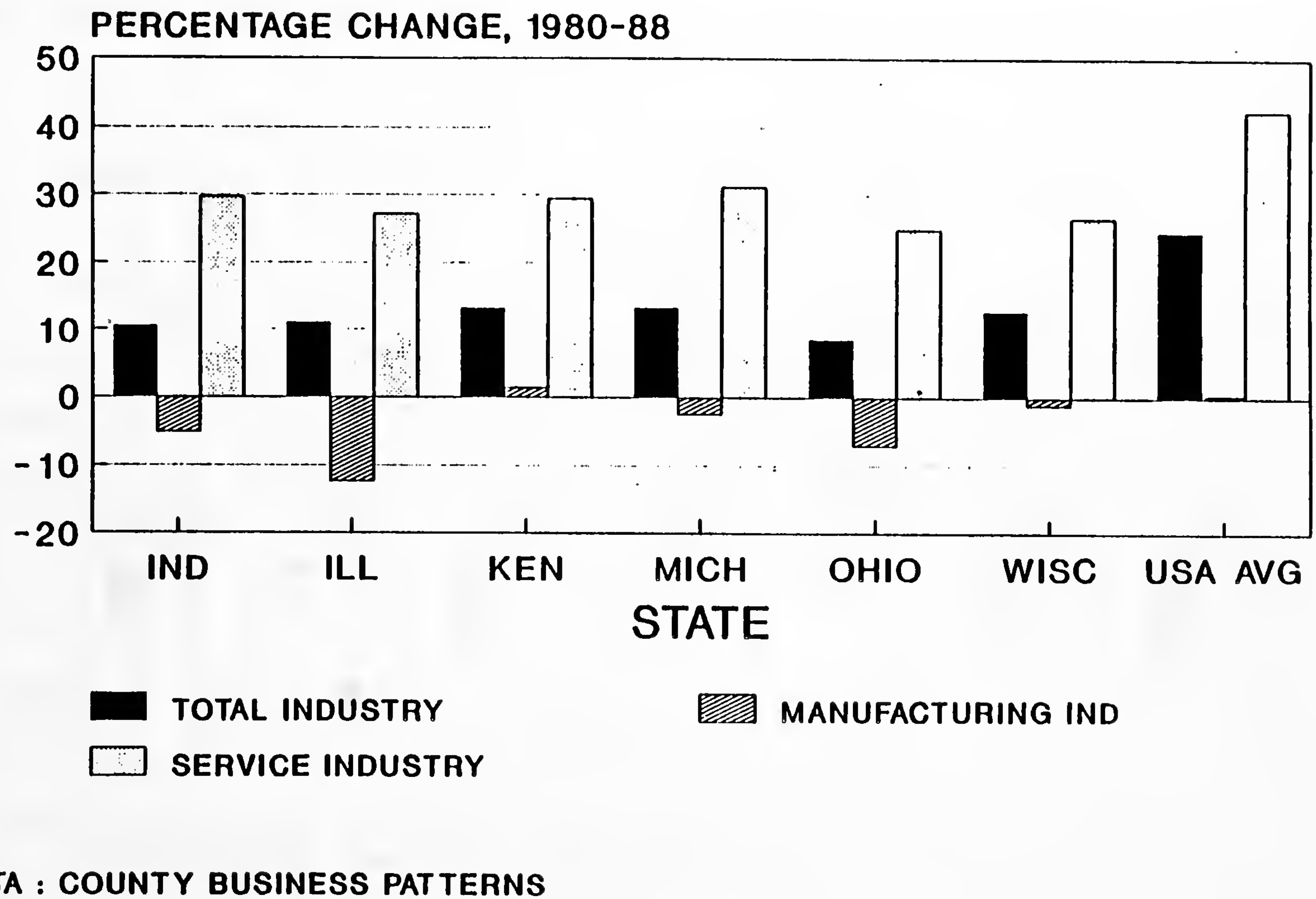


Figure 3.10 Regional Percentage Change in Wage-Income from 1980 to 1988

similar trends are evident from this figure when compared to the employment change figure (Figure 3.9), namely an increase in total wage-income that was positive but less than the aggregate US wage-income change of about 25 percent. Indiana's total wage-income increased by only 10.6 percent, which was the lowest in the region except for Ohio, at 8.5 percent. The overall US manufacturing wage-income increased by 0.4 percent. This is contrasted to Indiana's decrease by 5.2 percent, the third highest decrease in the region. Of all the states included in the analysis, only Kentucky showed an increase of 1.4 percent in wage-income in manufacturing. Service industry wage-income increased overall in all states in the study, but in none as much as the US increase of almost 43 percent. Indiana showed an increase of about 30 percent, lower than only Michigan and about the same as Kentucky.

The following summary conclusions can be made concerning the employment and wage-income changes in Indiana, its surrounding states and the United States as a whole, between 1980 and 1988:

- Indiana had a strong manufacturing industry base in 1980, compared to other states in the region and the country as a whole. The overall decline in the manufacturing sector over the time period affected all states and the country negatively, but to a different extent. In 1988 Indiana still had a strong manufacturing base. Manufacturing wage-income per

capita in Indiana was on par with the other states in 1980, and although it decreased over the time period due to the decline in employment, Indiana's relative position in the region improved to 1988.

- In the service industry sector, Indiana did not compare very well with the other states in the region in either 1980 or 1988. In both years, it ranked fourth in terms of its service industry base per capita. Service employment change between 1980 and 1988 was however on par with the other states, but the region as a whole lagged behind the country. Service industry per capita wage-income in Indiana was also ranked fifth out of the six regional states in both years, but the wage-income from this sector showed a high increase in the region.

- As far as the total employment situation is concerned, trends identified in the two preceding paragraphs were combined. Indiana ranked fourth in total employment per capita in both 1980 and 1988, and also in total employment change between those two years. This situation was the same for wage-income per capita in all sectors in 1980 and 1988, and Indiana ranked second lowest concerning change in total wage-income between 1980 and 1988.

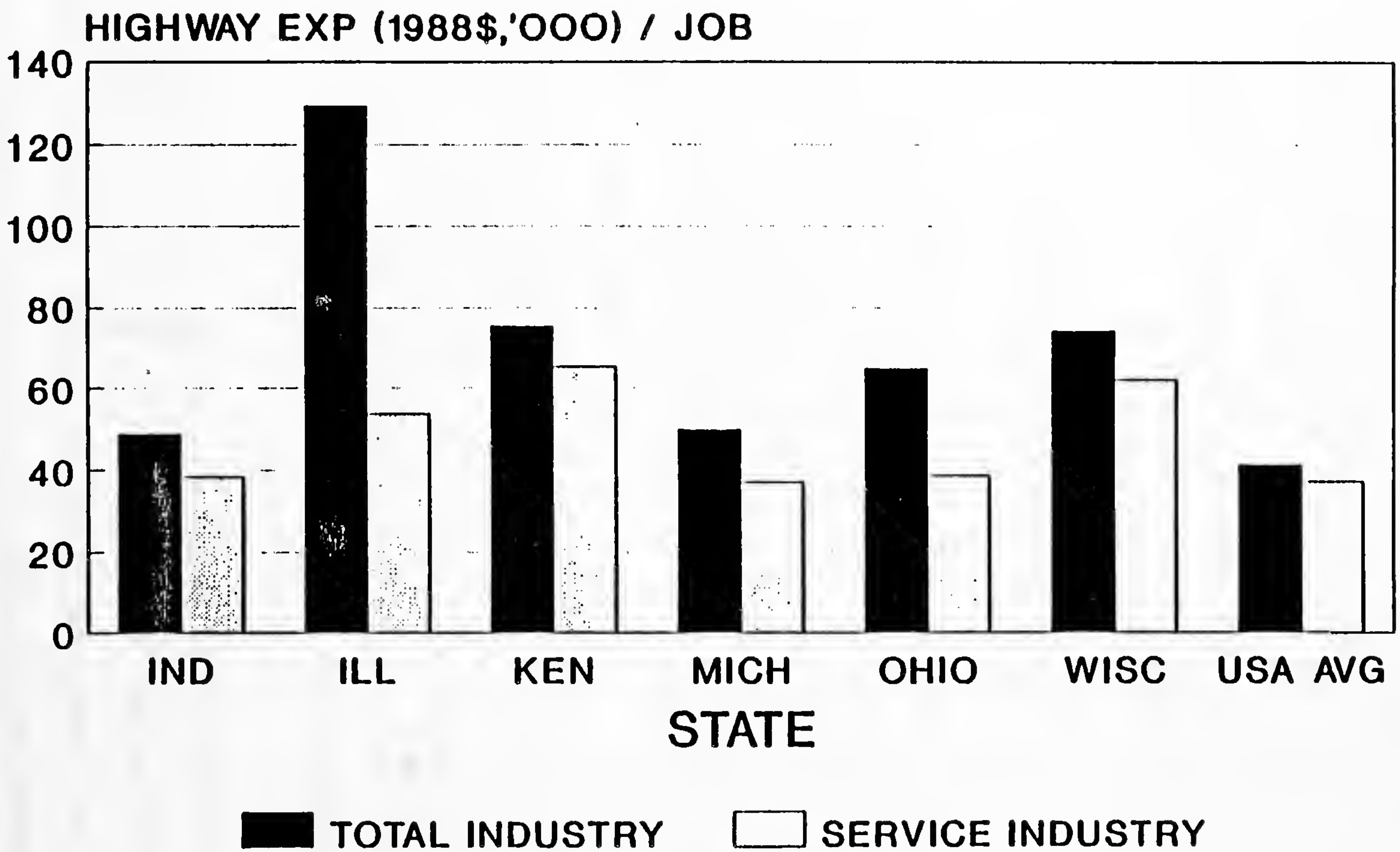
- The region as a whole, except for Illinois, seemed to lag behind the rest of the country in the service employment per

capita in both 1980 and 1988, as well as change in total and service industry employment and wage-income between 1980 and 1988. This could indicate that although the region has good highway infrastructure and especially a strong manufacturing sector, changes in the overall US economy such as a decrease in manufacturing and increase in service industries could affect it adversely.

Highways and Economic Growth

Figure 3.11 presents graphically a combination of total highway expenditures between 1980 and 1988 in constant dollars, and employment changes in all sectors, as well as in the service sector. It should be noted that this presentation of highway expenditures per job change over the time period does not imply at all that the expenditures necessarily caused the changes in employment. Also, the manufacturing sector is not shown because there was an overall decline in this sector in the US and all the states included in this analysis, due to external changes in the US economy, and it would have no meaning to make such a comparison.

From the figure it is evident that for total employment, the expenditure per job change from 1980 to 1988 in Indiana was about $48,600, compared to the US average of $41,250. Indiana had the lowest expenditure of all states in the region, while Illinois spent $129,500 per job change. In the service sector



DATA : FHWA HIGHWAY STATISTICS 1980-9
COUNTY BUSINESS PATTERNS

Figure 3.11 Regional Highway Expenditure per Employment Change from 1980 to 1988

Indiana's expenditure of $38,200 was slightly higher than the US average, but in the region it was higher than only that of Michigan. This does not necessarily imply that Indiana had "efficient" economic growth in terms of the money spent on highways. Rather, it could also be interpreted that despite relatively low highway expenditures, the results of this had not yet been transferred to the economy, but could well do so in following years due to time lags involved.

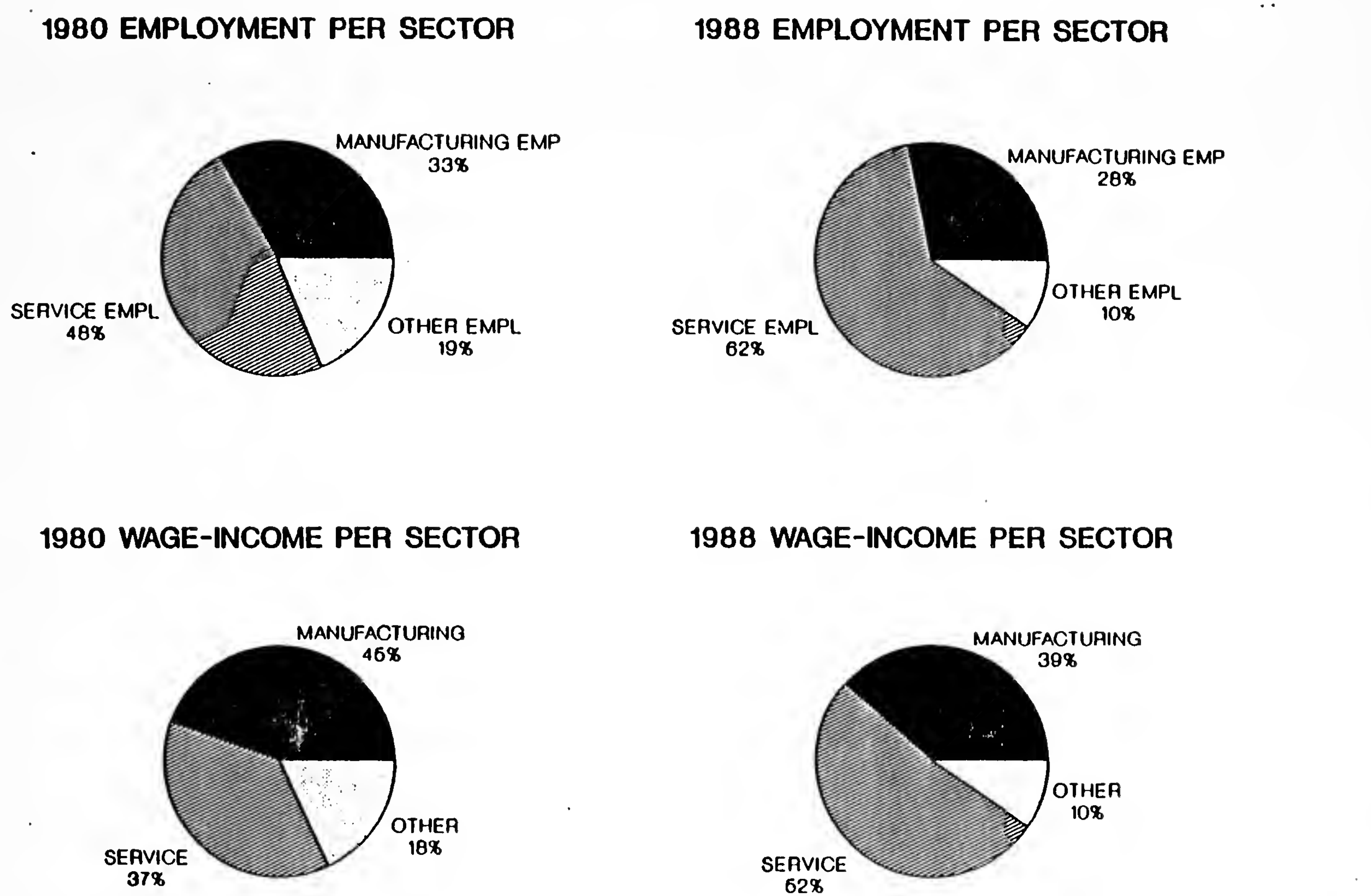
Indiana's Local Economy: 1980 to 1988

Over the past half-century, Indiana's economy has undergone some major changes. Prior to 1950, the state's economy was based on natural resources in terms of forestry and agriculture, with a basic manufacturing industry including steel works and motor vehicle production. In the 1950s, manufacturing played an increasing role in the state's economy, providing just less than 50 percent of the state's employment, and accounting for about 3.8 percent of overall U.S. manufacturing employment. After the 1950s, the state's role in the national economy declined, with jobs and income increasingly lower than the national average. This trend was concurrent with other states in the region, and can partly be attributed to the state's dependence on the manufacturing sector, which has shown slow growth nationally, and the overall shift in employment from manufacturing goods to providing services [IEDC 1988].

Figure 3.12 shows comprehensive sector data for 1980 and 1988, as used for this study. Employment and wage-income for different sectors in these two years are presented. From 1980 to 1988, the role of manufacturing employment in the state's total employment declined from one-third to 28 percent, while service employment showed a gain from 48 percent to over 60 percent. Employment outside these two sectors, such as in agriculture and in mining, declined by half considering its state-wide share.

Over the same time-period, manufacturing wage-income as a percentage of total state-wide wage-income declined from 45 percent to just under 40 percent. Service industry wage-income showed a gain from 37 percent to 52 percent, while other wage-income declined again by about half. It should be noted that although by 1988 service industries had overtaken manufacturing in both employment and wage-income as the main sector, in both 1980 and 1988 manufacturing's wage-income share was much higher than its employment share in the state's economy, indicating the lucrativeness of this type of industry in the state.

In the rest of this section, a disaggregate analysis is presented of the changes in the Indiana economy from 1980 to 1988. Initially, the county-by-county economic changes were examined for the economic development parameters of employment and wage-income in the manufacturing sector, the service



DATA : INDIANA DEPT OF EMP & TRNG SERVICES

Figure 3.12 Indiana Industry Shares of Employment and Wage-Income in 1980 and 1988

industry sector, and for all sectors combined. Then the changes in individual sectors, specifically the 43 SIC groups that been identified under the previous section, were investigated.

Total Employment and Wage-Income Change per County

In Table 3.2, the employment and wage-income levels for all counties in Indiana in 1980 and 1988 are presented, as well as the changes associated with each. Over this time period, the total employment in the state grew by about 15 percent. This figure is comprised of a net increase in employment in 81 counties, and a decrease in 11 counties. Actual increases of more than 15,000 jobs took place in Allen, Elkhart, Marion and St. Joseph Counties. The only county showing a significant actual decrease is Lake County, which lost a total of about 19,000 jobs.

As far as percentage changes are concerned, Elkhart, Hamilton, Dekalb, Steuben and Owen Counties showed an increase of more than 50 percent in employment. Only the first two counties had a significant employment base in 1980, while that of the other three counties was a smaller base. The only county with a decrease of more than 10 percent was Sullivan County.

In the total wage-income category, 1980 values were inflated to 1988 values by using Consumer Price Indices. Marion, Allen

Table 3.2 1980 and 1988 Total Employment and Wage-Income

COUNTY	TOTAL INDUSTRY EMPLOYMENT				TOTAL INDUSTRY WAGE-INCOME (Million, '88$)			
	1980	1988	ACTUAL CHANGE	% CHANGE	1980	1988	ACTUAL CHANGE	% CHANGE
ADAMS	9,721	12,554	2,833	29.14%	169.47	231.21	61.7	36.43%
ALLEN	133,880	160,418	26,538	19.82%	2,876.79	3,450.43	573.6	19.94%
BARTHOLOMEW	30,908	32,339	1,431	4.63%	726.62	775.91	49.3	6.78%
BENTON	2,393	2,150	(243)	-10.15%	38.45	32.48	(6.0)	-15.52%
BLACKFORD	4,129	4,296	167	4.04%	71.18	73.28	2.1	2.96%
BOONE	8,482	10,275	1,793	21.14%	137.13	170.43	33.3	24.28%
BROWN	1,525	2,030	505	33.11%	16.76	22.62	5.9	34.94%
CARROLL	4,113	4,207	94	2.29%	63.42	63.26	(0.2)	-0.25%
CASS	13,733	14,846	1,113	8.10%	253.45	255.48	2.0	0.80%
CLARK	26,654	31,972	5,318	19.95%	477.30	563.31	86.0	18.02%
CLAY	4,671	5,723	1,052	22.52%	79.31	97.74	18.4	23.24%
CLINTON	8,522	9,625	1,103	12.94%	135.20	155.61	20.4	15.10%
CRAWFORD	1,090	1,384	294	26.97%	15.51	18.15	2.6	17.02%
DAVIESS	6,004	7,702	1,698	28.28%	84.42	114.46	30.0	35.58%
DEARBORN	8,890	9,235	345	3.88%	176.26	182.71	6.4	3.66%
DECATUR	6,466	8,056	1,590	24.59%	114.89	148.12	33.2	28.92%
DEKALB	9,901	15,239	5,338	53.91%	183.20	297.51	114.3	62.40%
DELAWARE	44,068	47,164	3,096	7.03%	893.40	919.65	26.3	2.94%
DUBOIS	15,799	20,773	4,974	31.48%	274.84	373.64	98.8	35.95%
ELKHART	64,277	100,061	35,784	55.67%	1,276.34	1,979.61	703.3	55.10%
FAYETTE	10,753	10,873	120	1.12%	225.27	250.49	25.2	11.20%
FLOYD	15,191	18,828	3,637	23.94%	251.29	319.08	67.8	26.98%
FOUNTAIN	4,678	4,233	(445)	-9.51%	69.97	63.38	(6.6)	-9.42%
FRANKLIN	2,183	2,568	385	17.64%	31.75	39.42	7.7	24.16%
FULTON	5,660	6,377	717	12.67%	91.86	106.83	15.0	16.30%
GIBSON	8,849	9,474	625	7.06%	157.36	166.88	9.5	6.06%
GRANT	28,109	28,426	317	1.13%	586.61	624.75	38.1	6.50%
GREENE	5,366	6,930	1,564	29.15%	80.07	103.65	23.6	29.44%
HAMILTON	19,959	34,760	14,801	74.16%	361.62	745.88	384.3	106.26%
HANCOCK	8,432	9,789	1,357	16.09%	150.80	181.60	30.8	20.42%
HARRISON	4,585	6,266	1,681	36.66%	65.21	87.54	22.3	34.24%
HENDRICKS	11,347	15,526	4,179	36.83%	196.69	268.58	71.9	36.55%
HENRY	12,200	12,668	468	3.84%	225.30	235.22	9.9	4.40%
HOWARD	37,945	40,560	2,615	6.89%	967.94	1,110.41	142.5	14.72%
HUNTINGTON	11,415	13,720	2,305	20.19%	184.40	225.02	40.6	22.03%
JACKSON	12,280	14,031	1,751	14.26%	201.64	239.38	37.7	18.72%
JASPER	6,479	7,525	1,046	16.14%	112.69	131.89	19.2	17.04%
JAY	7,198	6,433	(765)	-10.63%	122.77	102.75	(20.0)	-16.30%
JEFFERSON	9,864	10,531	667	6.76%	177.73	183.65	5.9	3.33%
JENNINGS	4,622	5,655	1,033	22.35%	71.72	86.52	14.8	20.64%
JOHNSON	17,631	25,171	7,540	42.77%	273.88	385.17	111.3	40.63%
KNOX	13,247	13,976	729	5.50%	221.34	221.63	0.3	0.13%
KOSCIUSKO	20,876	26,842	5,966	28.58%	390.83	556.57	165.7	42.41%
LAGRANGE	6,331	8,740	2,409	38.05%	103.03	146.98	44.0	42.66%
LAKE	202,558	183,431	(19,127)	-9.44%	5,082.75	4,029.98	(1,052.8)	-20.71%
LAPORTE	39,160	41,350	2,190	5.59%	765.11	766.09	1.0	0.13%

Table 3.2. continued

COUNTY	1980 TOTAL EMP	1988 TOTAL EMP	ACTUAL CHANGE	% CHANGE	TOTAL INDUSTRY WAGE-INCOME (Million, '88$) 1980	1988	ACTUAL CHANGE	% CHANGE
LAWRENCE	11,291	12,696	1,405	12.44%	230.01	251.34	21.3	9.28%
MADISON	44,843	47,298	2,455	5.47%	1,034.01	1,123.90	89.9	8.69%
MARION	401,523	468,258	66,735	16.62%	8,852.67	10,597.15	1,744.5	19.71%
MARSHALL	12,200	15,315	3,115	25.53%	204.07	257.31	53.2	26.09%
MARTIN	2,207	2,711	504	22.84%	35.30	44.99	9.7	27.43%
MIAMI	8,331	8,401	70	0.84%	129.92	132.35	2.4	1.87%
MONROE	35,492	46,111	10,619	29.92%	613.25	809.16	195.9	31.95%
MONTGOMERY	11,852	14,777	2,925	24.68%	230.44	280.05	49.6	21.53%
MORGAN	8,430	11,408	2,978	35.33%	129.91	183.21	53.3	41.03%
NEWTON	3,300	3,860	560	16.97%	50.80	57.88	7.1	13.92%
NOBLE	10,383	14,557	4,174	40.20%	173.28	243.57	70.3	40.57%
OHIO	447	492	45	10.07%	5.35	6.04	0.7	13.00%
ORANGE	5,277	6,274	997	18.89%	73.60	90.48	16.9	22.93%
OWEN	1,604	2,599	995	62.03%	21.26	33.74	12.5	58.68%
PARKE	2,516	2,945	429	17.05%	36.33	40.75	4.4	12.16%
PERRY	5,417	4,972	(445)	-8.21%	86.61	81.93	(4.7)	-5.40%
PIKE	3,093	3,017	(76)	-2.46%	80.93	69.95	(11.0)	-13.57%
PORTER	37,148	40,208	3,060	8.24%	874.34	869.26	(5.1)	-0.58%
POSEY	6,553	7,481	928	14.16%	143.99	177.66	33.7	23.38%
PULASKI	2,946	3,773	827	28.07%	51.25	70.08	18.8	36.73%
PUTNAM	7,348	7,834	486	6.61%	130.82	135.75	4.9	3.76%
RANDOLPH	8,958	8,950	(8)	-0.09%	168.53	165.18	(3.3)	-1.99%
RIPLEY	7,287	9,262	1,975	27.10%	132.93	187.75	54.8	41.24%
RUSH	4,301	4,347	46	1.07%	70.38	67.40	(3.0)	-4.24%
SCOTT	3,888	5,139	1,251	32.18%	62.94	77.56	14.6	23.23%
SHELBY	11,081	12,664	1,583	14.29%	186.16	213.11	26.9	14.47%
SPENCER	3,944	5,763	1,819	46.12%	70.54	108.03	37.5	53.15%
STARKE	3,583	4,219	636	17.75%	51.35	56.00	4.7	9.06%
STEUBEN	7,157	13,542	6,385	89.21%	117.08	237.15	120.1	102.56%
STJOSEPH	93,932	109,141	15,209	16.19%	1,877.20	2,154.12	276.9	14.75%
SULLIVAN	4,922	4,189	(733)	-14.89%	109.10	71.69	(37.4)	-34.29%
SWITZERLAND	1,152	1,390	238	20.66%	15.53	17.77	2.2	14.40%
TIPPECANOE	48,029	56,775	8,746	18.21%	952.95	1,118.75	165.8	17.40%
TIPTON	4,005	3,878	(127)	-3.17%	65.88	65.04	(0.8)	-1.27%
UNION	940	1,095	155	16.49%	13.33	14.36	1.0	7.72%
VANDERBURGH	81,175	88,341	7,166	8.83%	1,581.70	1,707.37	125.7	7.95%
VERMILLION	4,075	4,642	567	13.91%	95.02	107.26	12.2	12.88%
VIGO	46,390	43,905	(2,485)	-5.36%	848.17	791.61	(56.6)	-6.67%
WABASH	13,273	13,453	180	1.36%	236.08	238.91	2.8	1.20%
WARREN	1,648	1,637	(11)	-0.67%	29.83	28.60	(1.2)	-4.14%
WARRICK	10,969	12,199	1,230	11.21%	333.53	306.18	(27.3)	-8.20%
WASHINGTON	4,056	5,772	1,716	42.31%	59.80	87.25	27.4	45.89%
WAYNE	29,068	30,458	1,390	4.78%	549.61	562.89	13.3	2.42%
WELLS	7,258	8,747	1,489	20.52%	134.45	155.46	21.0	15.63%
WHITE	7,247	8,068	821	11.33%	118.93	133.31	14.4	12.09%
WHITLEY	7,028	10,055	3,027	43.07%	124.83	187.87	63.0	50.50%
TOTAL	1,971,691	2,259,338	287,647	14.59%	40,428	45,722	5,294.54	13.10%

and Elkhart Counties, which had shown significant employment increases, also showed wage-income increases of over $500 million in constant values. Only Lake County showed a significant decrease in absolute wage-income, namely over $1 billion. Counties which increased their wage-income by more than 50 percent are the same as those that showed this percentage increase in employment, with Spencer and Whitley Counties added to the list. Only Lake and Sullivan Counties showed percentage decreases of more than 20 percent.

In summary, the most extensive increase in total employment and wage-income occurred in Marion County and in some counties in the Northern part of the state. The most extensive decrease occurred in the Northwestern part of the state. In the following sections, it will be investigated in which industries these changes took place.

Manufacturing Employment and Wage-Income Change per County

Table 3.3 presents data on the changes in the manufacturing sector in Indiana over the time period. As in the rest of the US and the region, there was a general decrease in manufacturing activity from 1980 to 1988, an average of about 3 percent for both parameters.

The most substantial actual changes took place in a few key counties. Elkhart County's manufacturing jobs increased by

Table 3.3 1980 and 1988 Manufacturing Employment and Wage-Income

COUNTY	MANUFACTURING INDUSTRY EMPLOYMENT				MANUFACTURING INDUSTRY WAGE-INCOME (Million, '88$)			
	1980	1988	ACTUAL CHANGE	% CHANGE	1980	1988	ACTUAL CHANGE	% CHANGE
ADAMS	4,971	6,858	1,887	37.96%	105.5	154.7	49.2	46.68%
ALLEN	39,132	39,301	169	0.43%	1,171.4	1,211.4	39.9	3.41%
BARTHOLOMEW	16,223	14,796	(1,427)	-8.80%	495.8	484.9	(10.9)	-2.20%
BENTON	267	316	49	18.35%	4.4	5.5	1.1	24.50%
BLACKFORD	2,037	2,029	(8)	-0.39%	42.7	44.7	2.0	4.67%
BOONE	1,553	1,729	176	11.33%	35.9	39.4	3.5	9.87%
BROWN	62	84	22	35.48%	0.9	1.2	0.3	27.65%
CARROLL	1,304	1,059	(245)	-18.79%	21.5	20.7	(0.8)	-3.82%
CASS	4,791	5,739	948	19.79%	114.9	119.4	4.5	3.91%
CLARK	7,912	7,355	(557)	-7.04%	192.6	184.5	(8.0)	-4.18%
CLAY	877	1,534	657	74.91%	18.3	33.1	14.8	80.54%
CLINTON	3,222	3,593	371	11.51%	61.6	75.3	13.6	22.15%
CRAWFORD	134	149	15	11.19%	1.8	1.6	(0.2)	-12.36%
DAVIESS	1,193	1,750	557	46.69%	19.1	24.7	5.6	29.35%
DEARBORN	3,401	2,544	(857)	-25.20%	88.7	77.3	(11.5)	-12.94%
DECATUR	2,551	3,342	791	31.01%	59.5	83.3	23.7	39.88%
DEKALB	4,935	8,629	3,694	74.85%	115.7	207.5	91.7	79.25%
DELAWARE	13,320	11,117	(2,203)	-16.54%	397.6	343.4	(54.2)	-13.64%
DUBOIS	7,750	10,137	2,387	30.80%	151.0	201.3	50.3	33.28%
ELKHART	33,393	56,626	23,233	69.57%	784.7	1,269.8	485.2	61.83%
FAYETTE	6,128	5,849	(279)	-4.55%	165.1	183.4	18.4	11.12%
FLOYD	4,036	5,046	1,010	25.02%	81.2	103.8	22.5	27.72%
FOUNTAIN	2,032	1,450	(582)	-28.64%	36.6	29.4	(7.2)	-19.69%
FRANKLIN	652	734	82	12.58%	11.9	14.3	2.3	19.53%
FULTON	2,696	2,868	172	6.38%	50.2	54.4	4.2	8.38%
GIBSON	2,863	2,857	(6)	-0.21%	66.5	63.1	(3.4)	-5.08%
GRANT	12,924	11,211	(1,713)	-13.25%	359.2	373.5	14.3	3.98%
GREENE	955	1,375	420	43.98%	15.6	21.2	5.6	35.68%
HAMILTON	4,368	5,494	1,126	25.78%	103.7	127.4	23.7	22.83%
HANCOCK	2,446	2,343	(103)	-4.21%	63.0	71.2	8.2	13.04%
HARRISON	1,205	1,409	204	16.93%	19.5	24.1	4.5	23.08%
HENDRICKS	1,084	1,107	23	2.12%	22.4	20.4	(2.0)	-9.03%
HENRY	3,881	3,346	(535)	-13.79%	109.1	102.9	(6.2)	-5.65%
HOWARD	19,813	18,435	(1,378)	-6.96%	681.9	760.4	78.4	11.50%
HUNTINGTON	5,436	6,233	797	14.66%	102.6	121.6	19.1	18.61%
JACKSON	4,799	5,011	212	4.42%	89.5	102.9	13.3	14.87%
JASPER	1,226	1,399	173	14.11%	21.3	25.1	3.8	17.81%
JAY	3,718	2,969	(749)	-20.15%	76.1	56.6	(19.4)	-25.53%
JEFFERSON	2,689	3,607	918	34.14%	52.5	79.2	26.7	50.78%
JENNINGS	1,278	1,578	300	23.47%	25.4	30.9	5.5	21.61%
JOHNSON	4,234	4,592	358	8.46%	86.9	98.9	12.0	13.82%
KNOX	2,276	1,606	(670)	-29.44%	49.0	35.2	(13.8)	-28.19%
KOSCIUSKO	10,297	13,235	2,938	28.53%	234.5	349.0	114.5	48.84%
LAGRANGE	2,338	3,968	1,630	69.72%	45.1	79.6	34.5	76.52%
LAKE	79,433	45,124	(34,309)	-43.19%	2,775.2	1,527.8	(1,247.4)	-44.95%
LAPORTE	15,278	13,203	(2,075)	-13.58%	366.1	314.8	(51.4)	-14.03%

Table 3.3, continued

COUNTY	MANUFACTURING INDUSTRY EMPLOYMENT 1980	1988	ACTUAL CHANGE	% CHANGE	MANUFACTURING INDUSTRY WAGE-INCOME (Million, '88$) 1980	1988	ACTUAL CHANGE	% CHANGE
LAWRENCE	4,342	4,703	361	8.31%	117.2	137.7	20.5	17.45%
MADISON	19,824	17,136	(2,688)	-13.56%	658.4	671.9	13.5	2.05%
MARION	103,009	84,736	(18,273)	-17.74%	3,092.6	2,787.7	(304.9)	-9.86%
MARSHALL	4,892	6,581	1,689	34.53%	100.4	130.8	30.4	30.26%
MARTIN	591	618	27	4.57%	12.0	12.4	0.4	3.52%
MIAMI	3,122	2,733	(389)	-12.46%	58.9	54.0	(4.9)	-8.24%
MONROE	7,773	9,413	1,640	21.10%	169.9	220.4	50.5	29.71%
MONTGOMERY	4,859	6,298	1,439	29.62%	126.2	153.5	27.3	21.60%
MORGAN	1,814	2,495	681	37.54%	33.6	47.5	13.9	41.31%
NEWTON	941	1,188	247	26.25%	16.0	20.7	4.8	29.77%
NOBLE	5,422	8,012	2,590	47.77%	105.7	155.1	49.4	46.76%
OHIO	15	26	11	73.33%	0.2	0.4	0.2	121.16%
ORANGE	2,058	2,617	559	27.16%	29.6	41.1	11.5	38.70%
OWEN	319	668	349	109.40%	5.8	10.5	4.7	81.41%
PARKE	404	483	79	19.55%	6.4	6.9	0.5	8.20%
PERRY	2,402	1,838	(564)	-23.48%	43.6	36.8	(6.8)	-15.61%
PIKE	149	145	(4)	-2.68%	2.4	2.1	(0.3)	-12.41%
PORTER	13,930	11,401	(2,529)	-18.16%	493.9	410.4	(83.5)	-16.91%
POSEY	2,349	2,897	548	23.33%	71.1	97.7	26.6	37.41%
PULASKI	704	1,355	651	92.47%	16.3	33.9	17.7	108.52%
PUTNAM	2,122	1,215	(907)	-42.74%	52.7	24.3	(28.5)	-53.96%
RANDOLPH	4,809	4,392	(417)	-8.67%	112.4	105.7	(6.7)	-5.94%
RIPLEY	3,726	4,332	606	16.26%	87.0	119.5	32.5	37.35%
RUSH	1,152	1,055	(97)	-8.42%	24.8	22.5	(2.2)	-8.99%
SCOTT	1,241	1,699	458	36.91%	26.4	33.9	7.5	28.50%
SHELBY	4,463	4,968	505	11.32%	89.2	104.0	14.8	16.63%
SPENCER	1,036	1,368	332	32.05%	19.8	26.8	7.0	35.11%
STARKE	816	1,068	252	30.88%	16.0	16.6	0.6	3.57%
STEUBEN	2,423	6,016	3,593	148.29%	52.0	123.6	71.6	137.70%
STJOSEPH	25,841	23,763	(2,078)	-8.04%	720.3	649.0	(71.3)	-9.89%
SULLIVAN	514	340	(174)	-33.85%	7.6	5.0	(2.5)	-33.36%
SWITZERLAND	604	561	(43)	-7.12%	8.4	7.5	(1.0)	-11.32%
TIPPECANOE	11,507	12,443	936	8.13%	328.3	354.7	26.5	8.06%
TIPTON	740	428	(312)	-42.16%	18.5	12.7	(5.8)	-31.53%
UNION	73	57	(16)	-21.92%	1.6	1.0	(0.6)	-37.92%
VANDERBURGH	22,882	18,924	(3,958)	-17.30%	557.5	510.9	(46.6)	-8.35%
VERMILLION	1,507	1,635	128	8.49%	46.4	54.1	7.8	16.71%
VIGO	13,347	8,776	(4,571)	-34.25%	315.8	238.5	(77.2)	-24.46%
WABASH	6,408	5,858	(550)	-8.58%	137.2	132.1	(5.1)	-3.70%
WARREN	576	590	14	2.43%	15.4	15.1	(0.3)	-1.95%
WARRICK	4,133	3,832	(301)	-7.28%	180.2	144.2	(36.0)	-19.98%
WASHINGTON	1,677	2,838	1,161	69.23%	28.7	48.7	19.9	69.46%
WAYNE	10,859	9,466	(1,393)	-12.83%	277.0	237.3	(39.7)	-14.33%
WELLS	2,978	3,168	190	6.38%	71.4	70.5	(0.9)	-1.22%
WHITE	2,681	2,905	224	8.36%	52.8	57.3	4.5	8.52%
WHITLEY	3,052	4,915	1,863	61.04%	69.6	111.9	42.3	60.69%
TOTAL	657,199	636,691	(20,508)	-3.12%	18,071.2	17,613.7	(457.52)	-2.53%

more than 20,000, while Lake and Marion Counties lost respectively more than 34,000 and 18,000 jobs. The percentage increase was more than 50 percent in several counties, but of all these only Elkhart County had a manufacturing base of more than 5,000 jobs in 1980. Of the 8 counties that had an decrease in manufacturing employment of more than 25 percent, only Lake and Vigo Counties had significant base year employment figures, of more than 10,000 employees.

As far as changes in wage-income are concerned, only two counties showed impressive actual increases, namely Elkhart County at $485 million, and Kosciusko County at $115 million. Lake County had the highest decrease at $1.25 billion, followed by Marion County at over $300 million. A total of ten counties showed an increase in wage-income in the manufacturing sector, of which only Elkhart County had a significant base of more 5,000 workers in 1980. While 7 counties showed a decrease of more than 25 percent, only Lake County, at minus 45 percent, had a significant base year employment and wage-income.

In summary, although the state-wide decrease in manufacturing sector employment and wage-income was relatively small, this was only the average of a wide variety of trends in different counties. The most significant changes in this sector took place in a few key counties, namely increases in Elkhart and Kosciusko Counties, and decreases in Lake and Marion Counties.

Service Employment and Wage-Income Change per County

In general, service-related industries showed a positive growth in the US and the East-North Central Region of the country over the past decade. This trend was also evident in the state of Indiana.

Table 3.4 presents data on changes in service employment and wage-income over the time period of 1980 to 1988. Overall, there was an increase in service employment in all Indiana counties. The majority of job increases occurred in Marion County, with a growth of almost 110,000. Three other counties, namely Allen, Lake and St. Joseph, showed an increase of more than 20,000 jobs. The total increase for the state was about 460,000 jobs. Of the 7 counties showing a gain of more than 100 percent, only Hamilton and Monroe Counties had a base year employment of more than 10,000. The average increase per county was just less than 50 percent.

All the counties in the state also showed an increase in constant 1988 dollars in wage-income, except for Benton County, which had a very small service industry base in 1980. Seven counties showed an increase of more than $300 million, with Marion County leading by a total of $2.53 billion, followed by Allen and Lake Counties. The number of counties that increased their wage-income from the service sector by more than 100 percent over the time period is twelve, but

Table 3.4 1980 and 1988 Service Employment and Wage-Income

COUNTY	SERVICE INDUSTRY EMPLOYMENT 1980	1988	ACTUAL CHANGE	% CHANGE	SERVICE INDUSTRY WAGE-INCOME (Millions, 1988 $) 1980	1988	ACTUAL CHANGE	% CHANGE
ADAMS	3,130	4,828	1,698	54.25%	39.6	62.5	22.9	57.92%
ALLEN	75,965	107,894	31,929	42.03%	1,303.7	1,952.6	648.8	49.77%
BARTHOLOMEW	9,860	15,181	5,321	53.97%	147.0	244.1	97.1	66.02%
BENTON	1,228	1,437	209	17.02%	22.0	21.4	(0.6)	-2.65%
BLACKFORD	1,346	2,027	681	50.59%	17.9	25.6	7.7	43.15%
BOONE	4,714	6,956	2,242	47.56%	66.4	101.0	34.6	52.09%
BROWN	986	1,619	633	64.20%	9.0	16.9	7.9	88.07%
CARROLL	1,768	2,340	572	32.35%	25.4	32.0	6.7	26.28%
CASS	5,607	7,891	2,284	40.73%	81.7	114.7	33.0	40.41%
CLARK	13,725	21,852	8,127	59.21%	195.6	331.6	136.0	69.55%
CLAY	2,235	3,433	1,198	53.60%	29.5	46.4	16.9	57.29%
CLINTON	3,343	4,881	1,538	46.01%	41.4	61.9	20.5	49.57%
CRAWFORD	407	886	479	117.69%	4.2	10.4	6.2	149.57%
DAVIESS	3,205	4,556	1,351	42.15%	37.8	60.0	22.2	58.79%
DEARBORN	3,471	5,679	2,208	63.61%	53.1	88.8	35.7	67.24%
DECATUR	2,620	4,026	1,406	53.66%	36.4	55.2	18.8	51.67%
DEKALB	3,546	5,698	2,152	60.69%	44.9	74.8	30.0	66.81%
DELAWARE	22,052	32,439	10,387	47.10%	326.2	511.1	185.0	56.70%
DUBOIS	5,858	8,922	3,064	52.30%	83.6	139.3	55.7	66.65%
ELKHART	24,167	38,423	14,256	58.99%	362.2	612.6	250.4	69.11%
FAYETTE	3,289	4,439	1,150	34.97%	40.3	57.5	17.2	42.71%
FLOYD	7,027	11,682	4,655	66.24%	97.9	178.5	80.6	82.38%
FOUNTAIN	1,669	2,340	671	40.20%	20.0	27.7	7.7	38.70%
FRANKLIN	893	1,505	612	68.53%	10.1	20.2	10.1	99.54%
FULTON	1,868	2,820	952	50.96%	25.5	37.7	12.3	48.10%
GIBSON	4,421	5,610	1,189	26.89%	61.7	84.3	22.6	36.64%
GRANT	11,793	15,450	3,657	31.01%	166.7	220.5	53.8	32.26%
GREENE	2,535	3,954	1,419	55.98%	28.6	48.2	19.6	68.48%
HAMILTON	10,891	24,275	13,384	122.89%	175.6	517.8	342.2	194.92%
HANCOCK	3,510	6,065	2,555	72.79%	46.9	88.8	41.9	89.48%
HARRISON	2,071	3,911	1,840	88.85%	26.9	50.7	23.9	88.91%
HENDRICKS	6,482	11,586	5,104	78.74%	109.2	191.9	82.8	75.80%
HENRY	4,748	7,991	3,243	68.30%	60.7	112.0	51.3	84.46%
HOWARD	13,403	19,873	6,470	48.27%	195.3	307.3	111.9	57.32%
HUNTINGTON	4,178	6,503	2,325	55.65%	53.3	85.0	31.7	59.59%
JACKSON	5,071	7,539	2,468	48.67%	72.3	112.1	39.8	55.01%
JASPER	3,281	5,041	1,760	53.64%	54.2	86.9	32.7	60.38%
JAY	2,256	2,913	657	29.12%	27.9	39.2	11.3	40.47%
JEFFERSON	4,627	6,211	1,584	34.23%	75.5	94.5	19.0	25.20%
JENNINGS	1,254	3,551	2,297	183.17%	14.8	46.9	32.2	218.02%
JOHNSON	9,347	18,119	8,772	93.85%	122.5	242.8	120.4	98.29%
KNOX	6,903	10,898	3,995	57.87%	100.2	161.4	61.2	61.13%
KOSCIUSKO	7,995	11,698	3,703	46.32%	114.8	175.8	60.9	53.06%
LAGRANGE	2,345	3,880	1,535	65.46%	33.7	53.3	19.6	58.28%
LAKE	89,241	117,388	28,147	31.54%	1,525.3	2,013.0	487.7	31.97%
LAPORTE	16,783	23,049	6,266	37.34%	259.4	351.7	92.3	35.56%

Table 3.4, continued

COUNTY	SERVICE INDUSTRY EMPLOYMENT 1980	1988	ACTUAL CHANGE	% CHANGE	SERVICE INDUSTRY WAGE-INCOME (Millions, 1988 $) 1980	1988	ACTUAL CHANGE	% CHANGE
LAWRENCE	4,228	6,757	2,529	59.82%	59.7	91.4	31.7	53.01%
MADISON	18,624	25,880	7,256	38.96%	259.0	373.7	114.7	44.30%
MARION	229,708	339,046	109,338	47.60%	4,264.5	6,792.8	2,528.3	59.29%
MARSHALL	5,257	7,688	2,431	46.24%	71.5	109.6	38.1	53.33%
MARTIN	976	1,779	803	82.27%	13.4	26.5	13.1	98.22%
MIAMI	3,270	4,843	1,573	48.10%	41.2	65.1	23.9	57.96%
MONROE	15,760	32,984	17,224	109.29%	216.7	517.8	301.0	138.90%
MONTGOMERY	4,932	7,123	2,191	44.42%	70.5	102.4	31.9	45.18%
MORGAN	4,237	7,695	3,458	81.61%	57.3	116.7	59.4	103.77%
NEWTON	1,363	1,963	600	44.02%	17.9	25.5	7.6	42.52%
NOBLE	3,155	5,448	2,293	72.68%	40.1	70.7	30.7	76.51%
OHIO	236	367	131	55.51%	2.4	4.6	2.2	94.21%
ORANGE	2,087	2,831	744	35.65%	24.8	35.6	10.8	43.32%
OWEN	728	1,564	836	114.84%	7.6	17.7	10.1	132.25%
PARKE	1,263	1,724	461	36.50%	16.3	23.2	7.0	42.92%
PERRY	1,800	2,321	521	28.94%	22.0	29.7	7.6	34.56%
PIKE	1,209	1,781	572	47.31%	23.2	35.2	11.9	51.46%
PORTER	15,587	25,450	9,863	63.28%	226.5	395.0	168.5	74.41%
POSEY	2,495	3,444	949	38.04%	37.9	57.7	19.8	52.25%
PULASKI	1,329	1,910	581	43.72%	20.8	27.7	6.9	32.97%
PUTNAM	3,410	5,251	1,841	53.99%	47.1	86.4	39.4	83.66%
RANDOLPH	2,635	3,754	1,119	42.47%	34.2	49.0	14.8	43.28%
RIPLEY	2,418	4,216	1,798	74.36%	29.9	57.3	27.3	91.28%
RUSH	1,810	2,612	802	44.31%	24.3	36.0	11.7	48.18%
SCOTT	1,518	2,931	1,413	93.08%	18.9	35.9	17.0	89.66%
SHELBY	4,343	6,335	1,992	45.87%	60.9	87.0	26.1	42.81%
SPENCER	1,731	3,533	1,802	104.10%	24.0	59.7	35.7	148.54%
STARKE	1,730	2,765	1,035	59.83%	21.0	34.8	13.7	65.34%
STEUBEN	3,713	6,741	3,028	81.55%	48.5	100.7	52.2	107.51%
STJOSEPH	53,915	75,952	22,037	40.87%	868.2	1,312.5	444.3	51.17%
SULLIVAN	1,667	3,076	1,409	84.52%	23.9	49.5	25.6	106.94%
SWITZERLAND	225	611	386	171.56%	2.6	7.3	4.7	184.23%
TIPPECANOE	23,246	39,901	16,655	71.65%	333.7	675.0	341.3	102.28%
TIPTON	1,365	2,395	1,030	75.46%	19.3	36.9	17.6	90.96%
UNION	525	852	327	62.29%	6.7	11.2	4.5	66.61%
VANDERBURGH	46,521	60,895	14,374	30.90%	761.9	998.7	236.8	31.08%
VERMILLION	1,376	2,385	1,009	73.33%	19.8	35.7	15.9	80.53%
VIGO	24,446	31,148	6,702	27.42%	364.8	482.0	117.2	32.12%
WABASH	4,652	6,545	1,893	40.69%	63.6	91.0	27.4	43.00%
WARREN	709	865	156	22.00%	8.7	10.9	2.3	26.46%
WARRICK	3,544	5,826	2,282	64.39%	53.6	93.1	39.5	73.77%
WASHINGTON	1,380	2,432	1,052	76.23%	15.8	31.9	16.1	101.59%
WAYNE	13,157	18,442	5,285	40.17%	187.2	277.5	90.3	48.22%
WELLS	3,025	4,926	1,901	62.84%	41.9	74.5	32.7	78.01%
WHITE	3,098	4,508	1,410	45.51%	43.9	64.8	20.8	47.47%
WHITLEY	2,516	4,415	1,899	75.48%	32.5	63.6	31.0	95.30%
TOTAL	944,033	1,405,169	461,136	48.85%	15,096.8	23,750.1	8,653.3	57.32%

these are mostly smaller counties, except for Hamilton, Monroe and Tippecanoe Counties.

In summary, it is clear that service industry prospered throughout the state of Indiana in the 1980s. Although this trend was general in all counties, some counties benefitted most from it, namely Allen, Lake and Marion County.

Employment and Wage-Income Change by Industrial Sector

In this section, the changes in the two economic development parameters were investigated for each of the 43 SIC groups that had been identified earlier in the chapter. Table 3.5 presents employment data for all sectors, in 1980 and 1988, as well as total and percentage changes. Although there was an overall increase in employment in the state, there was a large variance in changes across these sectors.

In the general industry or activity category, depicted by SIC groups 1 to 4, there was a decrease in two groups, and an increase in the other two groups. In the manufacturing sector, more industries showed a job increase than a decrease, namely 9 as opposed to 7. Major decreases did however take place in the primary metal industry (SIC group 15), and in the electric and electronic equipment industry (SIC group 18). These declines also explain why there was an overall loss in this type of employment in the state. Only SIC group 12, which is

Table 3.5 1980 and 1988 Employment by Standard Industrial Classification Group

SIC GROUP	SIC CODES	DESCRIPTION	EMPLOYMENT 1980	1988	ACTUAL CHANGE	% CHANGE
1	1,2,7,8,9	AGRICULTURE, FORESTRY, FISHING	11,943	16,952	5,009	41.94%
2	12,13,14	MINING	10,272	8,230	(2,042)	-19.88%
3	15,17	GENERAL AND SPECIAL CONTRACTING	72,847	92,141	19,294	26.49%
4	16	HEAVY CONSTRUCTION	18,932	14,621	(4,311)	-22.77%
5	20	FOOD PRODUCTS	37,567	34,388	(3,179)	-8.46%
6	22,23	TEXTILE PRODUCTS, CLOTHING	10,987	10,972	(15)	-0.14%
7	24	LUMBER AND WOOD PRODUCTS	18,558	24,188	5,630	30.34%
8	25	FURNITURE	19,280	22,567	3,287	17.05%
9	26	PAPER PRODUCTS	13,471	13,449	(22)	-0.16%
10	27	PRINTING AND PUBLISHING	30,181	36,894	6,713	22.24%
11	28	CHEMICAL PRODUCTS	28,812	29,945	1,133	3.93%
12	29,30	PETRO,COAL,PLASTIC,RUBBER PRODUCTS	35,768	52,428	16,660	46.58%
13	31	LEATHER PRODUCTS	2,351	2,458	107	4.55%
14	32	STONE, CLAY, GLASS PRODUCTS	22,124	17,301	(4,823)	-21.80%
15	33	PRIMARY METAL INDUSTRIES	101,573	69,150	(32,423)	-31.92%
16	34	FABRICATED METAL PRODUCTS	55,149	55,373	224	0.41%
17	35	INDUSTRIAL MACHINERY	75,442	65,972	(9,470)	-12.55%
18	36	ELECTRIC, ELECTRONIC EQPMNT	101,505	81,359	(20,146)	-19.85%
19	37	TRANSPORTATION EQUIPMENT	82,805	89,977	7,172	8.66%
20	38,39	INSTRUMENTS, MISC. MANUFACTURING	21,750	30,332	8,582	39.46%
21	41,42,44,45,47	TRUCKING,WAREHOUSING,TRANSPORTATION	43,251	68,180	24,929	57.64%
22	48	COMMUNICATIONS	25,531	23,480	(2,051)	-8.03%
23	49	ELECTRIC, GAS, SANITARY SERVICES	21,512	22,594	1,082	5.03%
24	50	WHOLESALE DURABLE TRADE	64,457	75,052	10,595	16.44%
25	51	WHOLESALE NON-DURABLE TRADE	42,491	44,322	1,831	4.31%
26	52	BUILDING MATERIALS, GARDEN SUPPLIES	16,487	20,691	4,204	25.50%
27	53	GENERAL MERCHANDISE STORES	54,476	55,819	1,343	2.47%
28	54	FOOD STORES	55,295	66,238	10,943	19.79%
29	55,75	AUTO DEALERS, REPAIR, PARKING	55,451	72,298	16,847	30.38%
30	56	APPAREL, ACCESSORY STORES	18,771	21,536	2,765	14.73%
31	58	EATING AND DRINKING PLACES	117,098	156,932	39,834	34.02%
32	57,59	FURNITURE AND MISC. RETAIL	63,108	72,389	9,281	14.71%
33	60 TO 65	FINANCE, INSURANCE, REAL ESTATE	98,460	114,947	16,487	16.74%
34	70	HOTELS AND LODGING	17,706	20,854	3,148	17.78%
35	72	PERSONAL SERVICES	20,310	23,785	3,475	17.11%
36	73	BUSINESS SERVICES	39,852	75,727	35,875	90.02%
37	76	MISC. REPAIR SERVICES	5,027	6,931	1,904	37.88%
38	78,79	MOTION PICTURES, AMUSEMENT SERVICES	15,740	22,503	6,763	42.97%
39	80	HEALTH SERVICES	118,698	161,882	43,184	36.38%
40	81	LEGAL SERVICES	7,054	9,707	2,653	37.61%
41	82,92,93	EDUCATION, LOCAL & STATE GOV EMPL	284,916	300,655	15,739	5.52%
42	83	SOCIAL SERVICES	20,418	28,677	8,259	40.45%
43	86 TO 89	MISC SERVICES	28,445	19,812	(8,633)	-30.35%
TOTALS			2,005,871	2,253,708	247,837	12.36%

petroleum, coal, rubber, and related products, showed an increase of more than 10,000 jobs. Percentage decreases were the greatest in the primary metal industry, where almost a third of the jobs in 1980 were non-existing in 1988. Three industries showed an increase of more than 30 percent on 1980 employment levels, namely petro-coal products, instruments and miscellaneous manufacturing, and lumber and wood products (SIC groups 12,20 and 7 respectively).

In the service industry sector, all of the SIC groups showed an increase in employment from 1980 to 1988, except for the communications and miscellaneous services industries (SIC groups 22 and 43 respectively). The major increases, namely more than 30,000 jobs, were in SIC groups 39, 31, and 36, which are respectively health services, eating and drinking places, and business services. The only decrease of more than 5,000 jobs happened in the miscellaneous services sector, where less than 9,000 jobs were lost. This decrease was about 30 percent from 1980 levels. The sectors which showed a percentage employment growth of more than 50 percent were business services, and trucking, warehousing and transportation (respectively SIC groups 36 and 21).

Table 3.6 displays wage-income data and associated changes for the time period. Similar to the employment data for all sectors, this table indicates that there was overall an increase in this parameter, although there was a wide variety

Table 3.6 1980 and 1988 Wage-Income by Standard Industrial Classification Group

SIC GROUP	SIC CODES	DESCRIPTION	WAGE-INCOME (Millions, '88 $) 1980	1988	CHANGE IN WAGE-INCOME	% CHANGE IN WAGE-INCOME
1	1,2,7,8,9	AGRICULTURE, FORESTRY,FISHING	170.5	224.8	54.3	31.82%
2	12,13,14	MINING	343.3	272.1	(71.3)	-20.76%
3	15,17	GENERAL AND SPECIAL CONTRACTING	1,853.9	2,096.1	242.2	13.07%
4	16	HEAVY CONSTRUCTION	602.7	401.4	(201.3)	-33.40%
5	20	FOOD PRODUCTS	899.4	801.0	(98.4)	-10.94%
6	22,23	TEXTILE PRODUCTS, CLOTHING	157.4	162.1	4.7	3.00%
7	24	LUMBER AND WOOD PRODUCTS	364.6	469.9	105.3	28.87%
8	25	FURNITURE	365.3	432.0	66.7	18.26%
9	26	PAPER PRODUCTS	332.0	336.4	4.4	1.32%
10	27	PRINTING AND PUBLISHING	640.2	784.5	144.3	22.53%
11	28	CHEMICAL PRODUCTS	992.4	1,177.1	184.7	18.61%
12	29,30	PETRO,COAL,PLASTIC,RUBBER PRODUCTS	865.0	1,181.8	316.8	36.63%
13	31	LEATHER PRODUCTS	30.4	32.8	2.4	7.[illegible]%
14	32	STONE, CLAY, GLASS PRODUCTS	554.2	462.1	(92.1)	-16.62%
15	33	PRIMARY METAL INDUSTRIES	3,525.4	2,392.1	(1,133.2)	-32.15%
16	34	FABRICATED METAL PRODUCTS	1,362.4	1,385.4	23.0	1.69%
17	35	INDUSTRIAL MACHINERY	2,107.3	1,941.5	(165.8)	-7.87%
18	36	ELECTRIC, ELECTRONIC EQPMNT	2,697.4	2,387.7	(309.7)	-11.48%
19	37	TRANSPORTATION EQUIPMENT	2,715.8	2,901.9	186.1	6.85%
20	38,39	INSTRUMENTS, MISC. MANUFACTURING	468.0	769.6	301.6	64.44%
21	41,42,44,45,47	TRUCKING,WAREHOUSING,TRANSPORTATION	1,130.3	1,508.6	378.3	33.47%
22	48	COMMUNICATIONS	672.5	701.8	29.3	4.36%
23	49	ELECTRIC, GAS, SANITARY SERVICES	674.0	771.8	97.9	14.52%
24	50	WHOLESALE DURABLE TRADE	1,607.9	1,945.7	337.8	21.01%
25	51	WHOLESALE NON-DURABLE TRADE	967.9	1,005.0	37.2	3.84%
26	52	BUILDING MATERIALS, GARDEN SUPPLIES	273.9	310.2	36.3	13.25%
27	53	GENERAL MERCHANDISE STORES	620.7	570.9	(49.8)	-8.03%
28	54	FOOD STORES	753.4	700.9	(52.4)	-6.96%
29	55,75	AUTO DEALERS, REPAIR, PARKING	926.7	1,221.1	294.4	31.76%
30	56	APPAREL, ACCESSORY STORES	183.6	192.0	8.4	4.57%
31	58	EATING AND DRINKING PLACES	821.2	1,015.8	194.6	23.69%
32	57,59	FURNITURE AND MISC. RETAIL	813.5	924.9	111.4	13.69%
33	60 TO 65	FINANCE, INSURANCE, REAL ESTATE	1,837.6	2,419.3	581.6	31.65%
34	70	HOTELS AND LODGING	153.3	179.2	25.9	16.88%
35	72	PERSONAL SERVICES	231.5	256.4	24.8	10.73%
36	73	BUSINESS SERVICES	566.1	1,098.5	532.4	94.03%
37	76	MISC. REPAIR SERVICES	93.9	132.2	38.3	40.79%
38	78,79	MOTION PICTURES, AMUSEMENT SERVICES	143.1	222.5	79.4	55.48%
39	80	HEATH SERVICES	2,133.6	3,326.7	1,193.1	55.92%
40	81	LEGAL SERVICES	127.2	219.3	92.1	72.44%
41	82,92,93	EDUCATION, LOCAL & STATE GOV EMPL	4,934.8	5,830.9	896.1	18.16%
42	83	SOCIAL SERVICES	215.0	307.6	92.6	43.08%
43	86 TO 89	MISC SERVICES	427.5	222.4	(205.0)	-47.96%
TOTAL			41,356.7	45,696.0	4,339.3	10.49%

of changes in different sectors. In the general industry sector, changes were similar to employment changes. In the manufacturing sector, eleven of the sixteen industry groups showed increases in actual wage-income, of which only two industries (petro-coal products and miscellaneous manufacturing) had an increase of more than $300 million. These were also the only two industries that showed a percentage increase in wage-income of more than 30 percent. The primary metal industry showed a massive decrease in wage-income, namely $1.13 billion, or 32 percent from its 1980 levels. Only one other manufacturing industry group, namely electric and electronic equipment (SIC group 18), had a decrease of more than $300 million, which was equal to a 12 percent decline. Also, only one other industry group namely SIC group 14 (stone, clay, and glass products) showed a percentage decrease of more than 15 percent.

Three of the 23 service sector SIC groups showed a decline in wage-income from 1980 to 1988. Miscellaneous services (SIC group 43) showed a drastic decline, with 1988 levels of wage-income being $205 million or almost 50 percent lower than in 1980. Health services (SIC group 39) showed an increase of almost $1.2 billion, followed by education and local and state government (SIC group 41), finance, insurance and real estate (SIC group 33), and business services (SIC group 36), that each had a wage-income increase of more than $0.5 billion.

Four service industry groups demonstrated an expansion of more than 50 percent in wage-income.

In summary, this section identified industries that affected growth or decline in Indiana's economy from 1980 to 1988. It was evident that mainly one industry group showed big declines in both employment and wage-income, namely the primary metal industry (SIC 15). Although there was positive growth in many manufacturing and most service industry sectors, the former was relatively small, while the latter was significant in several sectors, especially health services (SIC 39). Due to the smaller manufacturing industry sector relative to the service sector in terms of employment and wages, the net effect was that the Indiana economy showed overall growth over the time period from 1980 to 1988.

CHAPTER 4

REGRESSION MODELS

The purpose of this part of the research was to assess, at the statewide level, the relationship between highway infrastructure and regional economic development. First an analysis methodology was determined, then models were formulated, and data were collected and analyzed.

Analysis Methodology

In order to determine the relationship between highways and economic development, it would be necessary to compare areas where no changes in the highway infrastructure were made over a period of time, compared to areas where such improvements were done in differing degrees and intensities. In effect this would be comparing different treatment groups and a control group.

In practice this is not possible. There are many factors, both endogenous and exogenous, that affect regional economic development, and it is not feasible to find different treatment groups where all other factors stay reasonably the same over a time period. This non-deterministic nature of the

problem, due to confounding of factors, necessitates another approach.

In regression analysis, an initial theoretical hypothesis is made in which a factor or factors (independent variables) have an impact on the factor of interest, or dependent variable. Data on all variables are collected, and a least-squares fit is done. Some statistical parameters from this analysis then indicate if there is a statistically significant association between each separate independent variable and the response or dependent variable, as well as what the nature of this relationship is, as indicated by the regression parameter. Typically this analysis is performed with historical data, and forecasting methods are used to determine future values of the response variable within specified confidence limits, given specified levels of the independent variables. It should be noted that regression analysis is a statistical method to determine relationships between given variables, but does not necessarily imply that the independent factors caused the response factor to respond the way it did. Causality is postulated in the original definition of important variables.

There are also specific statistical tests and parameters that can be performed and interpreted in regression analysis to find the statistical properties of the analysis or model. The first test is the F-test for significance of regression, which tests if all of the independent variables in the model had no

significant association with the response variable. In a thoroughly defined model this should, however, not be a significant factor, since at least one of the variables would have been significant.

Another more important statistical test is the t-test for individual regression parameters. This test determines if a specific parameter was significantly different from zero, with the test hypotheses :

$$H_0 : B_k = 0$$
$$H_A : B_k = 0$$

If the null hypothesis is rejected, it indicates that there was a statistically significant association between the behavior of the independent variable, and that of the dependent variable. The two-sided P-values derived from this test indicate the statistical evidence existing to support the null-hypothesis, namely that the specific variable is not significantly different from 0. This test does however not allow for the effects of multicollinearity, if it is present in the data.

Another important parameter is the adjusted coefficient of determination, or the adjusted R^2, which is a statistical measure that indicates the amount of variability in the dependent variable that is explained by the independent variables in a model. Although this parameter does not imply

that the dependent variable's behavior is explained by the independent variables, it is often used as a measure of how "good" a model is.

For the purpose of this study, it was decided to use multiple cross-sectional regression analysis. Initially, it was necessary to decide which independent variables determine the amount of economic development (response variable) that takes place in a region. It was also appropriate to find how these variables would be measured, over what time period, and at what geographic level, since the objective was to define a model for the state of Indiana.

Model Parameters

As seen from the literature review, a number of factors were hypothesized to determine the amount of economic development in a region. For industries considering location or expansion in a region, encouraging factors besides highway infrastructure were theorized to be :

- resource costs [Bartik 1985];
- accessibility to major airports for both passenger and freight transportation [Kuehn et al. 1979];
- presence of facilities to enhance the quality of life [Dillman 1979];
- the proximity to metropolitan areas, for access to production materials and markets [Luloff and Chittenden 1984];

- relative wage rates and the presence of similar industries in a region [Kriesel and McNamara 1990];
- local tax rates [McConnell and Schwab 1990], and
- education levels [Kriesel and McNamara 1990].

Many interrelated elements are responsible for economic development. A more extensive description of variables and reasons for their inclusion in the model, as well as how they were measured, will be given in the following section.

A geographic level of analysis had to be determined. It was decided to use the county level. County data were readily available for most of the variables, and although this is probably not the optimum level concerning disaggregation, further breakdown of the data provided insurmountable problems. Also, in similar research as reviewed in the literature study, county level data were often used.

The analysis was performed for 1980 to 1988. Reliable highway data at county level were not available for the years before 1980, and limited socio-economic data after 1988 were available at the time of the study.

Dependent Variable Definition

In similar studies performed in the past, economic development was measured in a variety of ways. For this study, it was

important to use a variable or variables on which data could be obtained at county level, and for some years in the past. It was assumed that economic development can be modeled as either the change in employment over the time period under consideration, or as the change in wage-income over the same period.

Independent Variable Definition

Highway Infrastructure Variables

Three types of parameters were used to measure highway infrastructure quality : road condition, road facility availability, and highway infrastructure expenditures. Each of these variables will now be defined.

Road Condition

In Indiana, several methodologies are used by the state highway department (INDOT) to measure road condition. One of these is the Roughness Number or RN, which is measured by driving along a road section with a profilometer, a device which measures the number of eighth-inch vertical displacements on the section, assuming that the less the displacements, the better the road condition is. These measurements can be used to determine the PSI or Pavement Serviceability Index, although not in a deterministic way, but

through statistical relationships developed for the state of Indiana.

Another method is the Pavement Serviceability Rating, or PSR. According to this method, which entails a visual rating of pavement surfaces, road condition can be divided into categories on a scale 0 to 5, with 0 indicating a dirt or gravel road, 1 a pavement in extremely deteriorated condition, and 5 a new or nearly new pavement.

Since 1985, INDOT has collected PSR data on the state highway system on a yearly basis, by performing visual inspection of the interstate and Other State Highway systems. The rating on the 0 to 5 scale were multiplied by 10, to amplify the difference between conditions and to allow persons performing the survey to distinguish between conditions. Although there could be obvious bias in the PSR data as it was a qualitative measurement, PSR data were more readily available for all the counties in the state than RN data, and it was decided to use PSR as an approximate measure of road condition for this study. State-wide PSR data were available from 1985 to 1988. A PSR index was determined for each county in the state in 1985 as the weighted average of the mileage. The PSR for each county is given in Table 4.1.

Table 4.1 Road Condition Variable Values per County

COUNTY	AVERAGE PSR	% POOR CONDITION	% PAVED ROADS
ADAMS	35.7	14.11%	48.36%
ALLEN	33.7	6.83%	66.38%
BARTHOLOMEW	35.5	2.59%	69.37%
BENTON	39.0	12.03%	33.86%
BLACKFORD	37.2	7.89%	80.26%
BOONE	36.5	2.80%	46.39%
BROWN	35.9	0.00%	59.09%
CARROLL	37.5	1.17%	52.65%
CASS	34.4	8.33%	64.54%
CLARK	35.7	0.14%	83.36%
CLAY	33.9	14.87%	67.48%
CLINTON	34.0	0.00%	74.51%
CRAWFORD	36.0	6.12%	43.12%
DAVIESS	30.0	33.36%	42.58%
DEARBORN	34.7	4.08%	66.26%
DECATUR	39.0	4.28%	97.68%
DEKALB	33.3	22.75%	58.61%
DELAWARE	35.4	2.50%	95.30%
DUBOIS	35.6	0.85%	51.86%
ELKHART	33.1	16.14%	82.44%
FAYETTE	34.9	0.00%	64.00%
FLOYD	35.2	12.67%	85.62%
FOUNTAIN	32.7	5.22%	96.68%
FRANKLIN	35.2	0.00%	51.85%
FULTON	34.5	0.30%	77.08%
GIBSON	35.7	3.93%	57.28%
GRANT	36.7	5.36%	77.00%
GREENE	33.6	17.47%	55.36%
HAMILTON	35.1	7.19%	77.52%
HANCOCK	35.5	0.00%	76.02%
HARRISON	34.5	0.00%	48.50%
HENDRICKS	36.6	5.48%	90.77%
HENRY	35.3	5.34%	60.74%
HOWARD	35.0	0.00%	61.85%
HUNTINGTON	35.2	10.17%	57.55%
JACKSON	34.7	0.24%	66.08%
JASPER	34.4	0.00%	38.78%
JAY	36.5	8.91%	49.41%
JEFFERSON	36.9	7.40%	72.60%
JENNINGS	36.1	0.53%	40.65%
JOHNSON	35.1	0.00%	97.42%
KNOX	35.2	12.83%	57.70%
KOSCIUSKO	34.9	3.87%	81.47%
LAGRANGE	33.7	3.17%	46.17%
LAKE	32.9	18.07%	84.85%
LAPORTE	33.4	6.08%	77.05%

Table 4.1, continued

COUNTY	AVERAGE PSR	% POOR CONDITION	% PAVED ROADS
LAWRENCE	34.6	1.00%	91.55%
MADISON	35.6	4.12%	82.31%
MARION	36.1	10.81%	96.21%
MARSHALL	32.1	29.03%	77.51%
MARTIN	31.5	16.23%	62.37%
MIAMI	34.1	8.25%	51.53%
MONROE	36.9	0.41%	73.38%
MONTGOMERY	34.4	7.64%	60.54%
MORGAN	35.3	0.00%	65.04%
NEWTON	29.3	36.56%	48.22%
NOBLE	33.5	15.80%	76.32%
OHIO	37.3	0.00%	80.29%
ORANGE	37.5	9.98%	45.99%
OWEN	33.4	9.05%	48.47%
PARKE	34.4	0.00%	59.83%
PERRY	31.7	46.62%	52.74%
PIKE	39.4	4.63%	47.39%
PORTER	33.8	6.22%	74.95%
POSEY	38.4	0.44%	39.41%
PULASKI	33.5	0.00%	44.11%
PUTNAM	33.8	0.00%	75.72%
RANDOLPH	37.5	0.00%	57.52%
RIPLEY	35.4	0.00%	73.18%
RUSH	36.8	18.97%	93.79%
ST. JOSEPH	33.0	21.25%	82.05%
SCOTT	37.3	0.86%	59.85%
SHELBY	34.1	21.62%	87.07%
SPENCER	34.0	17.42%	41.95%
STARKE	32.3	21.13%	65.29%
STEUBEN	34.6	21.15%	63.25%
SULLIVAN	34.5	4.40%	26.53%
SWITZERLAND	35.4	0.00%	60.90%
TIPPECANOE	34.7	0.14%	98.12%
TIPTON	34.0	0.00%	56.96%
UNION	36.9	16.32%	51.06%
VANDERBURGH	33.3	10.92%	89.27%
VERMILLION	31.5	19.09%	64.50%
VIGO	29.6	35.63%	74.99%
WABASH	32.1	17.54%	61.09%
WARREN	34.8	13.43%	45.67%
WARRICK	31.0	20.74%	58.00%
WASHINGTON	36.2	0.00%	67.04%
WAYNE	34.2	14.95%	99.91%
WELLS	33.0	10.52%	49.73%
WHITE	34.1	0.00%	44.53%
WHITLEY	32.5	21.62%	85.41%
AVERAGE	34.57	8.80%	65.71%

Other highway condition variables were also considered in this study. The first was the percentage of roads in a county which was in poor condition, or with a PSR of 2.5 or less. Although a PSR of 2.5 falls halfway between the poor and fair condition categories, this cut-off point was used because a very limited amount of miles fell in the PSR category of 2.0 or less. This percentage, for each county, is also indicated in Table 4.1. It should be noted that these percentages were also obtained from PSR data for the state system in 1985 which was the earliest year with comprehensive data.

The third and last measure of highway condition was the percentage of paved miles in a county, as contrasted to the unpaved mileage. These data were also obtained from INDOT, and the earliest available data were for the total road system in 1983, including both the state and local systems. The percentage of surfaced road mileage in each county in Indiana is presented in Table 4.1.

Highway Facility Availability

Indiana had in 1990 a total of about 92,000 miles of roads, of which almost 11,000 miles are interstates and Other State Highways (i.e. the state system). The remainder of the mileage fell under local jurisdiction. The state had over 1,100 interstate miles. This mileage changed very little over the previous decade. In order to define road facility availability

for the purposes of the model, three different measures were used to determine separate impacts by functional classification.

The first was the total mileage density of all highways in a county in 1980, in both the state and local systems. It was theorized that this is a good indication of highway availability in that county. The total mileage, unadjusted for the area of a county, is presented in Table 4.2. The second highway facility indicator was the multi-lane road mileage density in a county in 1980, or the roads that had more than two lanes. The literature review indicated that especially in the manufacturing sector, the availability of roads with at least four lanes is an important determinant of industry location decision-making. Data on multi-lane mileage in 1980 were also obtained from INDOT, and came from a different source than the total mileage, due to data collection procedures at the time. It was not possible to extract just the four-lane mileage from this data base, but this was not considered a problem, as the vast majority of multi-lane mileage in the state had four lanes. The multi-lane mileage, not adjusted for county area, is also presented in Table 4.2.

The third indicator was an approximation of the capacity of all the roads in a county, and was named the highway facility rating or HFR. The purpose of this measure was to amplify the effect of multi-lane highways, while combining two-lane and

Table 4.2 Total Mileage, Multi-lane Mileage, and Highway Facility Rating per County

COUNTY	1980 MULTI-LANE MILES	1980 TOTAL MILES	1980 HFR
ADAMS	0.00	875.91	2,452.55
ALLEN	116.03	2416.39	7,369.25
BARTHOLOMEW	38.14	1009.32	3,024.42
BENTON	28.76	837.12	2,493.49
BLACKFORD	0.00	430.91	1,206.55
BOONE	46.27	1076.00	3,253.40
BROWN	0.00	456.78	1,278.98
CARROLL	0.15	913.44	2,558.41
CASS	16.89	1108.96	3,192.92
CLARK	43.57	883.81	2,701.23
CLAY	25.10	886.23	2,611.96
CLINTON	20.06	1006.26	2,921.84
CRAWFORD	17.23	569.42	1,683.97
DAVIESS	1.24	979.94	2,750.28
DEARBORN	39.79	683.04	2,119.42
DECATUR	21.79	804.80	2,366.75
DEKALB	19.35	956.75	2,779.52
DELAWARE	45.73	1334.61	3,974.70
DUBOIS	3.92	858.48	2,424.13
ELKHART	38.59	1572.74	4,604.34
FAYETTE	0.00	488.43	1,367.60
FLOYD	21.80	511.60	1,545.84
FOUNTAIN	20.24	874.99	2,555.22
FRANKLIN	4.78	747.69	2,118.39
FULTON	14.13	936.05	2,694.42
GIBSON	30.36	1244.63	3,642.84
GRANT	26.25	1254.81	3,649.97
GREENE	0.33	1131.13	3,168.88
HAMILTON	40.24	1237.69	3,674.78
HANCOCK	40.91	832.85	2,544.71
HARRISON	18.66	986.67	2,859.71
HENDRICKS	49.66	1041.01	3,173.06
HENRY	50.68	1076.22	3,276.95
HOWARD	14.82	947.27	2,729.42
HUNTINGTON	46.14	962.28	2,934.31
JACKSON	24.84	1042.90	3,049.29
JASPER	32.29	1150.60	3,389.59
JAY	0.00	929.74	2,603.27
JEFFERSON	6.05	730.46	2,076.75
JENNINGS	0.00	804.58	2,252.82
JOHNSON	45.73	848.46	2,613.48
KNOX	39.28	1202.92	3,572.43
KOSCIUSKO	22.22	1478.66	4,255.79
LAGRANGE	24.83	942.53	2,768.20
LAKE	184.27	2445.57	7,805.80
LAPORTE	101.76	1619.23	5,063.00

Table 4.2, continued

COUNTY	1980 MULTI-LANE MILES	1980 TOTAL MILES	1980 HFR
LAWRENCE	14.84	919.98	2,654.57
MADISON	33.49	1551.83	4,306.25
MARION	277.04	3431.19	6,397.34
MARSHALL	47.12	1173.48	3,537.96
MARTIN	0.82	473.96	1,326.93
MIAMI	25.96	976.54	2,818.23
MONROE	26.88	878.07	2,591.37
MONTGOMERY	23.46	1099.24	3,192.42
MORGAN	49.76	904.01	2,793.62
NEWTON	34.90	821.45	2,486.78
NOBLE	0.52	1015.40	2,846.47
OHIO	0.00	174.75	493.39
ORANGE	0.08	768.65	2,156.92
OWEN	0.00	730.49	2,044.81
PARKE	0.15	883.86	2,478.39
PERRY	13.38	666.55	1,887.67
PIKE	0.00	687.40	1,903.30
PORTER	109.39	1276.50	4,147.48
POSEY	18.15	874.21	2,540.71
PULASKI	0.00	1003.03	2,807.84
PUTNAM	40.34	960.19	2,893.65
RANDOLPH	0.06	1077.14	3,018.29
RIPLEY	9.52	940.60	2,734.23
RUSH	0.20	888.06	2,468.74
SCOTT	12.17	457.21	1,336.16
SHELBY	32.97	1020.38	3,033.94
SPENCER	8.80	947.28	2,688.54
STARKE	13.34	835.69	2,412.38
STEUBEN	43.71	822.25	2,529.68
ST. JOSEPH	85.96	1835.88	4,455.11
SULLIVAN	25.93	1086.08	3,174.24
SWITZERLAND	0.00	456.64	1,279.49
TIPPECANOE	58.70	1287.72	3,914.33
TIPTON	12.95	665.67	1,930.94
UNION	0.00	323.19	903.73
VANDERBURGH	56.45	1035.40	2,715.26
VERMILLION	45.75	577.24	1,849.36
VIGO	62.78	1333.91	3,714.29
WABASH	0.48	974.14	2,721.41
WARREN	24.41	702.52	2,039.89
WARRICK	25.12	928.82	2,680.30
WASHINGTON	0.00	936.25	2,621.36
WAYNE	37.28	1093.34	3,266.91
WELLS	1.05	890.72	2,490.66
WHITE	15.54	1137.52	3,325.92
WHITLEY	18.31	814.58	2,378.53
TOTAL	2,690.64	91468.89	

multi-lane highways in the same variable. The separate mileages were weighted by the hourly 2-way capacity of two-lane and four-lane highways, namely respectively 2.8 and 8 thousand vehicles per hour. The equation that was used are thus :

$$HFR_i = [(2.8 * 2LN80_i) + (8 * G2LN80_i)]$$

where :

HFR_i = highway facility rating in county i;

$2LN80_i$ = the two-lane mileage in county i in 1980, and

$G2LN80_i$ = the multi-lane mileage in county in 1980.

Again, as with the second indicator, the four-lane mileage was approximated by the total multi-lane mileage in a county. The highway facility ratings for each county are also presented in Table 4.2. In all models this variable was also divided by the county area to adjust for differences due to county size.

For all three highway facility indicators, the 1980 levels were used as a base year value, assuming that the value in this year would be one of the factors that would determine economic development in Indiana over the following eight years, and also because the overall mileage change from 1980 to 1988 was very little. Due to high correlation and commonality in the purpose of the variable, these three indicators were not used simultaneously in any regression analysis, but were employed separately. In addition, highway

mileages in a county was divided by the area of the county, to normalize with respect to the size of the county, i.e. the larger the county, the more the road mileage in it.

Highway Expenditures

Although most of the highways in Indiana were constructed before 1980, more localized construction such as the upgrading of sections, bridge substitution, and extensive maintenance projects were undertaken over the period from 1980 to 1988. The hypothesis was that highway expenditure in a county would improve the road condition, and therefore cause more investment in the manufacturing and service sectors in the county. Because highway construction and maintenance on a system is a continuous process, the expenditures on road infrastructure from 1980 to 1988 was included as a proxy for road quality and extent.

The data collection effort did however prove to be difficult, due to a variety of reasons. Several units in INDOT keep track of expenditures at the different levels of government. It was finally decided to use a database from the Division of Policy and Budget, which proved to be the most comprehensive of all the available databases. Data were derived for the time period from 1980 to 1988.

Data were available on a contract-by-contract basis, with details of starting and completion dates, counties that were involved, and the total contract value. It was assumed that the main benefits from a project would only be realized once it was completed. This assumption was based on the fact that there was a large variety of projects, and also because most projects were short in duration. For projects in more than one county, the contract value was distributed evenly between all counties, due to the large number of projects involved. For projects in more than three counties however, the county names could not be extracted from the data base, and these contracts were subsequently excluded. These projects accounted for only about two percent of the total expenditures, and were typically projects such as road sign installation and pavement marking.

The expenditures that were included in the final database were those related to capital and major maintenance projects funded by the federal or state governments. Routine maintenance expenditure data were not incorporated, due to different accounting procedures that were used, fiscal year versus calendar year incompatibility, and data that were not county-specific. For the same reasons, it was not possible to get reliable data of local government spending on local projects. Typically, local capital expenditures are small relative to local routine maintenance expenditures.

When the total expenditures of all 92 counties and all years from 1980 to 1988 were determined, these amounts were converted to 1988 dollars by using Federal Highway Administration (FHWA) consumer price indices for highways and summed to get the total expenditures over the time period, per county, as shown in Table 4.3. The highway expenditures per area of a county were used in all regression analyses, to adjust for the size of a county, similar to the mileage parameters.

Electric Utility Rates

When industries, especially in the manufacturing sector, make location decisions, the local electric utility rate can influence the decision to select a specific county. Electric utility costs can have a significant impact on production costs, depending on the type of industry. It was therefore reasoned that electricity rates at the beginning of the time period under consideration, namely 1980, should be included as a variable in the statewide model.

Data were obtained from the Indiana Utilities Forecast Group, and the average rate for 1980 determined, measured in dollars per kilowatt-hour. Where more than one utility company operated in a specific county, the average yearly rate per company was weighted by the number of consumers that the

Table 4.3 1980 to 1988 Highway Expenditures per County

COUNTY	EXPENDITURES ($'000,1988 $)	COUNTY	EXPENDITURES ($'000,1988 $)
ADAMS	10,542	LAWRENCE	15,758
ALLEN	89,410	MADISON	33,625
BARTHOLOMEW	16,584	MARION	178,403
BENTON	14,321	MARSHALL	25,669
BLACKFORD	4,195	MARTIN	8,219
BOONE	33,885	MIAMI	17,780
BROWN	3,272	MONROE	24,222
CARROLL	7,612	MONTGOMERY	18,489
CASS	8,609	MORGAN	19,796
CLARK	23,697	NEWTON	18,560
CLAY	17,107	NOBLE	8,916
CLINTON	15,307	OHIO	2,570
CRAWFORD	12,737	ORANGE	7,726
DAVIESS	6,414	OWEN	4,251
DEARBORN	14,653	PARKE	11,398
DECATUR	25,999	PERRY	15,186
DEKALB	18,335	PIKE	9,513
DELAWARE	40,626	PORTER	75,167
DUBOIS	13,451	POSEY	12,743
ELKHART	25,547	PULASKI	6,409
FAYETTE	9,643	PUTNAM	19,893
FLOYD	13,466	RANDOLPH	9,331
FOUNTAIN	17,454	RIPLEY	10,255
FRANKLIN	12,451	RUSH	9,847
FULTON	10,995	ST.JOSEPH	28,836
GIBSON	18,371	SCOTT	5,083
GRANT	36,457	SHELBY	33,463
GREENE	20,684	SPENCER	20,873
HAMILTON	24,227	STARKE	12,516
HANCOCK	21,199	STEUBEN	13,764
HARRISON	11,002	SULLIVAN	27,771
HENDRICKS	44,802	SWITZERLAND	6,006
HENRY	24,543	TIPPECANOE	43,196
HOWARD	24,191	TIPTON	3,924
HUNTINGTON	20,232	UNION	6,751
JACKSON	22,589	VANDERBURGH	183,082
JASPER	20,324	VERMILLION	12,949
JAY	9,266	VIGO	45,574
JEFFERSON	15,245	WABASH	13,508
JENNINGS	5,099	WARREN	9,912
JOHNSON	14,812	WARRICK	9,459
KNOX	20,217	WASHINGTON	8,916
KOSCIUSKO	19,425	WAYNE	30,124
LAGRANGE	6,842	WELLS	11,952
LAKE	163,202	WHITE	13,182
LAPORTE	31,435	WHITLEY	11,864
		TOTAL	2,156,910

company had in 1980. The commercial electric rate was used for the service sector, and the industrial utility rate was used for the manufacturing sector. These rates are presented in Table 4.4.

Water Availability

The literature review for this study indicated that especially for the manufacturing sector, water availability is an important location determinant. While Indiana has abundant water resources as a state, this is not true for all regions in the state. The availability of water for industry use in large quantities in a specific county, as well as surface water for the disposal of treated effluent, can affect industrial location decisions.

Research indicated that there was no readily accessible water availability indicator per county, and such a measure had to be developed. Data were obtained from the Indiana Department of Natural Resources (IDNR) on the existence of ground water and surface water sources [IDNR 1980]. For ground water, the average well flow capacity in a county in gallons per minute was determined. Surface water sources were divided into rivers and lakes. For rivers, the 7-day low flow once in ten years for the biggest river in a county was used ($Q_{7,10}$), and for lakes the number of lakes in a county with a surface area of at least 50 acres or a capacity of more than 30.5 million

Table 4.4 1980 Electric Weighted Utility Rates per County

COUNTY	COMMERCIAL ELECTRIC RATE, 1980 $/kWH	INDUSTRIAL ELECTRIC RATE, 1980 $/kWH	COUNTY	COMMERCIAL ELECTRIC RATE, 1980 $/kWH	INDUSTRIAL ELECTRIC RATE, 1980 $/kWH
ADAMS	0.04070	0.0303	LAWRENCE	0.05170	0.0222
ALLEN	0.04070	0.0303	MADISON	0.04290	0.0287
BARTHOLOMEW	0.05170	0.0222	MARION	0.03530	0.0290
BENTON	0.05768	0.0393	MARSHALL	0.05719	0.0415
BLACKFORD	0.04070	0.0303	MARTIN	0.05170	0.0222
BOONE	0.04432	0.0253	MIAMI	0.05170	0.0222
BROWN	0.05170	0.0222	MONROE	0.05170	0.0222
CARROLL	0.05348	0.0273	MONTGOMERY	0.05170	0.0222
CASS	0.05170	0.0222	MORGAN	0.04465	0.0251
CLARK	0.05170	0.0222	NEWTON	0.05882	0.0426
CLAY	0.05170	0.0222	NOBLE	0.04432	0.0328
CLINTON	0.05170	0.0222	OHIO	0.05170	0.0222
CRAWFORD	0.05170	0.0222	ORANGE	0.05170	0.0222
DAVIESS	0.05170	0.0222	OWEN	0.05170	0.0222
DEARBORN	0.05170	0.0222	PARKE	0.05170	0.0222
DECATUR	0.05170	0.0222	PERRY	0.05170	0.0222
DEKALB	0.04577	0.0337	PIKE	0.04700	0.0260
DELAWARE	0.04070	0.0303	PORTER	0.05882	0.0426
DUBOIS	0.04210	0.0300	POSEY	0.04296	0.0293
ELKHART	0.04795	0.0352	PULASKI	0.05882	0.0426
FAYETTE	0.05170	0.0222	PUTNAM	0.05170	0.0222
FLOYD	0.05170	0.0222	RANDOLPH	0.04070	0.0303
FOUNTAIN	0.05170	0.0222	RIPLEY	0.05170	0.0222
FRANKLIN	0.05170	0.0222	RUSH	0.05170	0.0222
FULTON	0.05291	0.0257	SCOTT	0.05170	0.0222
GIBSON	0.04844	0.0248	SHELBY	0.05170	0.0222
GRANT	0.04081	0.0302	SPENCER	0.04210	0.0300
GREENE	0.05170	0.0222	STARKE	0.05882	0.0426
HAMILTON	0.05055	0.0227	STEUBEN	0.05610	0.0408
HANCOCK	0.05170	0.0222	STJOSEPH	0.04124	0.0307
HARRISON	0.05170	0.0222	SULLIVAN	0.05170	0.0222
HENDRICKS	0.04924	0.0232	SWITZERLAND	0.05170	0.0222
HENRY	0.05159	0.0223	TIPPECANOE	0.05170	0.0222
HOWARD	0.05170	0.0222	TIPTON	0.05027	0.0232
HUNTINGTON	0.05071	0.0229	UNION	0.05170	0.0222
JACKSON	0.05170	0.0222	VANDERBURGH	0.04210	0.0300
JASPER	0.05882	0.0426	VERMILLION	0.05170	0.0222
JAY	0.04070	0.0303	VIGO	0.05170	0.0222
JEFFERSON	0.05170	0.0222	WABASH	0.05159	0.0223
JENNINGS	0.05170	0.0222	WARREN	0.05291	0.0257
JOHNSON	0.05170	0.0222	WARRICK	0.04277	0.0295
KNOX	0.05170	0.0222	WASHINGTON	0.05170	0.0222
KOSCIUSKO	0.05875	0.0424	WAYNE	0.05170	0.0222
LAGRANGE	0.05882	0.0426	WELLS	0.04103	0.0301
LAKE	0.05882	0.0426	WHITE	0.05882	0.0426
LAPORTE	0.05683	0.0412	WHITLEY	0.04103	0.0301
			AVERAGE	0.05021	0.02711

gallons per day. Each of these three indicators were divided into categories for low, medium and high water availability, such that the number of counties in a category would be approximately evenly distributed. A weight was then allocated to allow for the availability level of the specific water source. The final water availability per county was therefore determined as :

$$WA_i = GWA_i + RWA_i + LWA_i$$

where:

WA_i = an index of the water availability in county i;

GW_i = an index of the ground water availability in county i, measured as the average well flow rate in gallons per minute (gpm), with low less than 130 gpm, high more than 340 gpm, and medium in between;

RWA_i = an index of the river water available in county i, measured as the 7-day low flow in gpm once in 10 years of the biggest river in the county, with low less than 52,000 gpm, high more than 208,000 gpm, and medium in between;

and LWA_i = an index of the lake water availability in county i, measured as the number of lakes in a county with surface area more than 50 acres or capacity more than 30.5 million gallons per day, with low less than 3 lakes, high more than 6 lakes, and medium in between.

A rating of "low" in any category was assigned an index value of 1, a "medium" a 2, and a "high" a 3. The final values of this variable are shown in Table 4.5.

Distance to Nearest Large Airport

Air transportation has become increasingly important over the past two decades. It could be reasoned that firms would prefer to operate within reasonable distance from a major airport, not only for access to passenger air transportation to the rest of the country, but also for freight transportation purposes. The latter consideration could be especially important for industries which produce high-technology, low-volume goods that often require rapid shipment to clients [Toft and Mahmassani 1985].

For this variable, large airports were considered those with more than 180,000 enplanements per year in 1988. The airports in the region meeting this characteristic were located at Chicago, Louisville, Dayton, Cincinnati, Champaign, Indianapolis, South Bend, Fort Wayne, and Evansville. The variable value for each county in the state was the straight-line distance from the center of the county to the closest of the above-mentioned nine airports, measured in miles. The counties in which the Indiana airports were located, were assigned a value of 0. These data are presented in Table 4.6.

Table 4.5 Water Availability per County

COUNTY	GROUND WATER	SURFACE WATER	# LAKES	TOTAL INDEX
ADAMS	346.0	0	2	5
ALLEN	311.5	20	4	5
BARTHOLOMEW	160.3	52	13	7
BENTON	86.2	0	0	3
BLACKFORD	360.0	0	1	5
BOONE	145.0	0	2	4
BROWN	18.0	0	24	5
CARROLL	340.0	208	3	7
CASS	372.0	208	1	6
CLARK	62.0	347	7	7
CLAY	42.5	20	3	4
CLINTON	370.0	0	1	5
CRAWFORD	47.5	347	2	5
DAVIESS	121.9	208	6	5
DEARBORN	59.5	347	3	6
DECATUR	53.3	0	6	4
DEKALB	400.0	20	6	6
DELAWARE	318.0	20	1	4
DUBOIS	23.5	208	15	6
ELKHART	664.0	347	6	8
FAYETTE	148.5	20	1	4
FLOYD	109.0	347	2	5
FOUNTAIN	131.0	347	6	7
FRANKLIN	109.0	52	1	4
FULTON	650.0	52	8	8
GIBSON	280.0	347	4	7
GRANT	340.0	0	3	6
GREENE	164.5	208	3	6
HAMILTON	388.0	52	2	6
HANCOCK	380.0	20	1	5
HARRISON	95.0	347	4	6
HENDRICKS	115.5	0	5	4
HENRY	348.0	20	3	6
HOWARD	410.0	0	2	5
HUNTINGTON	320.0	20	1	4
JACKSON	185.0	208	8	7
JASPER	181.0	208	1	5
JAY	270.0	0	0	4
JEFFERSON	73.2	347	2	5
JENNINGS	38.0	0	4	4
JOHNSON	120.5	52	10	6
KNOX	228.0	347	1	6
KOSCIUSKO	630.0	20	46	7
LAGRANGE	792.0	20	37	7
LAKE	325.0	347	6	7
LAPORTE	413.5	347	11	9
LAWRENCE	49.5	208	2	4

Table 4.5, continued

COUNTY	GROUND WATER	SURFACE WATER	# LAKES	TOTAL INDEX
MADISON	374.0	20	1	5
MARION	336.0	52	5	6
MARSHALL	600.0	20	12	7
MARTIN	66.0	208	5	5
MIAMI	380.0	208	1	6
MONROE	12.0	208	8	6
MONTGOMERY	130.0	20	2	4
MORGAN	181.5	208	23	7
NEWTON	207.0	208	1	5
NOBLE	710.0	20	58	7
OHIO	59.5	347	0	5
ORANGE	20.0	0	2	3
OWEN	67.0	208	10	6
PARKE	141.0	347	13	8
PERRY	60.7	347	11	7
PIKE	22.5	208	7	6
PORTER	372.5	347	8	9
POSEY	379.5	347	3	8
PULASKI	350.0	52	1	6
PUTNAM	81.5	20	5	4
RANDOLPH	355.0	0	2	5
RIPLEY	12.0	0	8	5
RUSH	124.7	20	2	3
SCOTT	25.0	0	11	5
SHELBY	280.0	20	0	4
SPENCER	204.0	347	7	8
STARKE	220.0	208	6	6
STEUBEN	560.0	0	41	7
STJOSEPH	680.0	347	3	8
SULLIVAN	132.5	347	8	8
SWITZERLAND	65.4	347	3	6
TIPPECANOE	335.0	347	0	6
TIPTON	400.0	0	0	5
UNION	128.0	20	1	3
VANDERBURGH	165.0	347	7	8
VERMILLION	82.0	347	0	5
VIGO	181.0	347	15	8
WABASH	380.0	52	11	8
WARREN	205.5	347	0	6
WARRICK	27.8	347	5	6
WASHINGTON	24.0	208	10	6
WAYNE	242.0	20	1	4
WELLS	330.0	0	1	4
WHITE	167.5	208	3	6
WHITLEY	470.0	20	13	7
AVERAGE	238.5	151.4	6.7	5.7

Table 4.6 Additional Variable Values per County

COUNTY	DISTANCE TO AIRPORT (MILES)	COLLEGE GRADUATES (%, 1980)	DISTANCE TO MSA (MILES)	RECREATIONAL ACREAGE (1988)	PROPERTY TAX RATE (1980)
ADAMS	25	8.54%	25	258	4.96
ALLEN	0	14.98%	0	2,929	5.30
BARTHOLOMEW	41	14.79%	35	1,066	4.94
BENTON	53	9.43%	27	58	3.45
BLACKFORD	41	7.15%	19	71	4.49
BOONE	20	15.70%	20	359	4.24
BROWN	39	14.31%	19	38,398	3.36
CARROLL	58	8.10%	24	146	3.20
CASS	69	8.89%	25	977	3.81
CLARK	14	9.21%	14	25,825	6.36
CLAY	58	8.26%	14	2,398	3.62
CLINTON	41	9.33%	20	231	3.94
CRAWFORD	39	5.60%	39	1,813	5.07
DAVIESS	55	7.11%	41	9,601	4.12
DEARBORN	22	9.57%	22	196	5.08
DECATUR	45	8.05%	46	174	3.55
DEKALB	22	8.47%	22	125	3.49
DELAWARE	48	14.93%	0	1,065	6.34
DUBOIS	44	10.24%	43	8,497	4.36
ELKHART	20	12.27%	0	2,337	4.52
FAYETTE	50	7.24%	50	221	4.97
FLOYD	13	10.58%	13	595	5.33
FOUNTAIN	45	7.95%	25	433	4.29
FRANKLIN	36	7.80%	36	16,919	3.86
FULTON	41	8.52%	41	362	3.83
GIBSON	22	8.96%	22	253	4.40
GRANT	44	9.73%	27	303	6.17
GREENE	66	7.27%	24	7,654	5.16
HAMILTON	20	25.73%	20	538	5.16
HANCOCK	19	11.33%	19	167	4.17
HARRISON	22	6.77%	22	28,246	3.40
HENDRICKS	19	14.39%	19	99	4.32
HENRY	41	7.35%	20	3,999	5.44
HOWARD	48	11.00%	0	1,302	5.33
HUNTINGTON	27	10.25%	27	20,024	4.34
JACKSON	45	7.37%	33	24,101	4.15
JASPER	63	9.31%	39	8,148	3.34
JAY	44	6.90%	27	145	4.49
JEFFERSON	42	12.20%	43	1,526	4.66
JENNINGS	53	6.83%	58	6,635	4.68
JOHNSON	19	13.25%	19	7,607	3.62
KNOX	50	9.85%	52	618	4.98
KOSCIUSKO	34	12.14%	28	3,852	3.60
LAGRANGE	41	6.91%	19	12,227	3.93
LAKE	31	10.09%	0	9,314	10.84
LAPORTE	28	10.61%	28	7,940	6.50
LAWRENCE	56	6.74%	24	1,744	3.72

Table 4.6, continued

COUNTY	DISTANCE TO AIRPORT (MILES)	COLLEGE GRADUATES (%, 1980)	DISTANCE TO MSA (MILES)	RECREATIONAL ACREAGE (1989)	PROPERTY TAX RATE (1980)
MADISON	36	10.37%	0	852	5.30
MARION	0	16.35%	0	10,128	6.54
MARSHALL	22	10.43%	22	269	4.11
MARTIN	64	7.33%	36	6,229	3.47
MIAMI	56	7.80%	25	206	4.90
MONROE	48	31.30%	0	46,813	5.03
MONTGOMERY	42	10.89%	24	3,961	4.22
MORGAN	23	9.45%	24	5,331	3.87
NEWTON	64	8.25%	44	14,021	4.36
NOBLE	27	7.35%	27	3,502	3.92
OHIO	31	7.90%	31	16	4.03
ORANGE	48	6.99%	49	25,696	4.00
OWEN	52	7.04%	17	7,153	4.34
PARKE	55	8.15%	24	7,101	3.90
PERRY	50	6.27%	50	186,489	3.67
PIKE	34	6.31%	35	10,558	2.91
PORTER	47	14.72%	16	17,531	4.61
POSEY	17	9.71%	17	7,994	3.33
PULASKI	47	8.01%	47	7,488	3.88
PUTNAM	38	12.10%	35	9,440	4.38
RANDOLPH	44	7.83%	20	208	3.04
RIPLEY	41	7.67%	41	6,132	3.42
RUSH	38	7.50%	38	32	3.79
SCOTT	30	5.30%	30	2,205	4.33
SHELBY	22	8.54%	22	90	4.28
SPENCER	31	8.40%	31	2,300	2.81
STARKE	36	6.50%	36	3,581	3.97
STEUBEN	39	9.75%	41	2,136	3.80
STJOSEPH	0	14.60%	0	6,268	6.71
SULLIVAN	78	7.78%	25	13,032	4.20
SWITZERLAND	44	5.62%	44	111	5.00
TIPPECANOE	58	25.52%	0	1,616	4.63
TIPTON	38	8.22%	13	154	4.10
UNION	38	8.98%	39	1,716	3.11
VANDERBURGH	0	12.52%	0	2,666	6.18
VERMILLION	41	7.78%	27	113	4.20
VIGO	61	16.26%	0	1,471	7.62
WABASH	38	11.83%	33	15,119	3.86
WARREN	44	8.26%	24	40	3.90
WARRICK	17	13.58%	17	1,821	3.52
WASHINGTON	34	5.95%	35	1,609	3.87
WAYNE	39	10.10%	36	1,233	4.98
WELLS	22	8.91%	22	1,136	4.25
WHITE	75	8.52%	27	129	3.63
WHITLEY	19	7.21%	19	309	3.66
AVERAGE	49	10.02%	25	7582	4.44

College Graduates

For businesses locating or expanding in a specific location, the available work force was hypothesized to be an important consideration. In this study, it was reasoned that the number of college graduates was of more importance than the number of high school graduates, in the light of increasing specialization of firms and higher expectations from the workers. As a measure of the availability of the schooled labor force availability in a county, the percentage of college graduates in the total county population was therefore used. These data included people with 4 or more years of college education in 1980, and were obtained from the 1980 Census of Population and Housing, performed by the US Bureau of the Census. The percentages are also given in Table 4.6.

Distance to Metropolitan Statistical Area (MSA)

Newly locating or existing firms that expand were reasoned to consider, amongst other factors, the proximity to metropolitan areas. The reasons for this are not only to be close to suppliers of materials used in production, but also for the distribution of goods and services, i.e. markets. This variable was the straight-line distance from the center of a county to the central city of the closest MSA. These data are also displayed in Table 4.6. The twelve counties in the state

of Indiana which were located in a MSA were each assigned a value of 0 for this variable.

Recreational Facilities

The availability of recreational facilities was included in the model as an approximation of the quality-of-life in a county. Although this factor could arguably be considered as marginal, it was regarded as possibly important for some industries, especially in the service sector. The acreage of the sum of the federal, state and local public parks that were operated in a county in 1988 was used. Although the number of visitors to such facilities would probably have been a better indicator because it indicates actual usage of parks, these data were not available for local facilities, which constitutes a significant portion of parks. The acreages were obtained from the Indiana Department of Natural Resources[IDNR 1990], and are given in Table 4.6.

Tax Rate

County property tax rates vary. This fact could affect location or expansion decisions, as industries are conjectured to minimize the cost of overhead expenditures. In this regard, it was decided that property tax rates would be an appropriate measure of perceived tax obligations. As a measurement of this

variable, the average property tax rate per county in 1980 was used. These data were also presented in Table 4.6.

Agglomeration Variable

For some industries, the presence of other industries in a region or a county could be a prerequisite before locating or expanding in a specific location. This phenomenon is called the agglomeration of industry, indicating that industries tend to go where other industries are already located. Reasons for this are an already existing industrialized environment with all its benefits, such as location on existing routes for freight companies for the delivery of raw materials and transportation of manufactured goods, locational incentives from local government level that are in place, and local authority sensitivity towards attracting and keeping industry.

In this study, the variable included to represent the agglomeration effect was approximated by the employment levels in a county in the first year of the study, namely 1980. For a specific industry or type of industry the 1980 employment in that industry were used, e.g. total manufacturing industry employment in 1980 in a county was used when explaining the change in manufacturing employment between 1980 and 1988.

Analysis of Data

Initially, a limited model was used to examine the effects that highway infrastructure had on regional economic development in Indiana from 1980 to 1988. Next, a complete model would be used, consisting of all the independent variables that were hypothesized to affect economic development, and that were specified above.

The Limited Model

In the limited model it was hypothesized that only highway infrastructure determined the economic development in the state over the study time period. This was done in order to analyze what the economic development effects were of only the highway parameters. The model that was used was defined as follows :

$$Y = X'B + e$$

where Y = the change in employment or wage income in all economic sectors, in the manufacturing sector, or in the service sector between 1980 and 1988, in a county;

X = a vector of highway parameters in a county, and

e = a vector of errors.

The highway parameters were defined as follows :

COND = the road condition variable, defined alternatively as the average weighted road condition of the state highway system in a county in 1985 [PSR], the percentage of roads with a PSR of 2.5 or less in a county in 1985 [POOR], and the percentage of the total highway system that was paved in a county in 1983 [PAVED];

MILES = the highway facility variable, defined alternatively as the total mileage [ROAD80], the multi-lane mileage [G2LN80], and the highway facility rating in 1980 [HFR], per area in a county, and

EXP = the total highway expenditures in a county, from 1980 to 1988 dollars, per area of the county [EXP].

The various combinations of highway variables that were used in different regressions were as follows :

PSR, POOR, PAVED, ROAD80, G2LN80, HFR, and EXP each individually, and in the combinations of

PSR + ROAD80 + EXP;

PSR + G2LN80 + EXP;

PSR + HFR + EXP;

POOR + ROAD80 + EXP;

POOR + G2LN80 + EXP;

POOR + HFR + EXP;

PAVED + ROAD80 + EXP;

PAVED + G2LN80 + EXP, and

PAVED + HFR + EXP.

From the model definition it can be seen that a variety of dependent variables were used individually, namely the parameters of change in employment and wage-income between 1980 and 1988 for the three different sectors of total, manufacturing, and service industries. These industry classifications were defined in Chapter 3, and were done according to Standard Industrial Classification code groupings. The results from these sets of analyses will be discussed separately for each economic sector.

Total Employment

Table 4.7 shows the results from the limited model, when using total employment change and total wage-income change between 1980 and 1988 are used separately as dependent variables, with different combinations of highway variables, as specified in the previous section. In this table, the estimated coefficient values of variables that were statistically significant in the regression are given, with an indication of the associated two-sided P-value from the t-tests for significance of individual variables, as well as the coefficient of multiple determination that had been adjusted for the number of variables in the model (adjusted R^2). The nature of the

Table 4.7 Results from Limited Model Regressions for Total Employment Sector

DEPENDENT VARIABLE : TOTAL EMPLOYMENT CHANGE 1980-88

INDEPENDENT VARIABLES

ROAD VARIABLE	CONDITION	MILES	EXP	R**2
PSR		#	#	-0.01
POOR		#	#	-0.01
PAVED	139***	#	#	0.06
1980 MILEAGE	#	6,930 ***	#	0.45
1980 > 2-LANE MILES	#	54,528 ***	#	0.33
HWY FAC RATING	#	2,086 ***	#	0.45
EXPENDITURES	#	#	32***	0.11
PSR + 1980MIL + EXP		8,741 ***	-22**	0.47
PSR + >2LN + EXP		62,322 ***		0.33
PSR + HFR + EXP		2,690 ***	-24**	0.47
POOR + 1980MIL + EXP		8,784 ***	-23**	0.47
POOR + >2LN + EXP		61,825 ***		0.32
POOR + HFR + EXP		2,702 ***	-25**	0.47
PAVED + 1980MIL + EX		8,686 ***	-23**	0.47
PAVED + >2LN + EXP		59,644 ***		0.32
PAVED + HFR + EXP		2,675 ***	-25**	0.47

NOTES :
= VARIABLE NOT INCLUDED IN REGRESSION
COEFFICIENT VALUES FOR SIGNIFICANT VARIABLES ARE SHOWN
SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :
*** = 1% OR LESS
** = 5% OR LESS
* = 10% OR LESS

Table 4.7, continued

DEPENDENT VARIABLE : TOTAL WAGE-INCOME CHANGE 1980-88

ROAD VARIABLE	CONDITION	MILES	EXP	R**2
	INDEPENDENT VARIABLES			
PSR		#	#	-0.01
POOR		#	#	-0.01
PAVED	2.7*	#	#	0.03
1980 MILEAGE	#	154 ***	#	0.30
1980 > 2-LANE MILES	#	1,137 ***	#	0.19
HWY FAC RATING	#	46 ***	#	0.29
EXPENDITURES	#	#	0.61**	0.05
PSR + 1980MIL + EXP		211 ***	-0.71**	0.34
PSR + >2LN + EXP		1,402 ***		0.20
PSR + HFR + EXP		64 ***	-0.74**	0.33
POOR + 1980MIL + EXP		213 ***	-0.72**	0.34
POOR + >2LN + EXP		1,386 ***		0.19
POOR + HFR + EXP		65 ***	-0.75**	0.33
PAVED + 1980MIL + EX		213 ***	-0.72**	0.33
PAVED + >2LN + EXP		1,340 ***		0.18
PAVED + HFR + EXP		65 ***	-0.75**	0.32

NOTES :
= VARIABLE NOT INCLUDED IN REGRESSION
COEFFICIENT VALUES FOR SIGNIFICANT VARIABLES ARE SHOWN
SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :
*** = 1% OR LESS
** = 5% OR LESS
* = 10% OR LESS

association of a specific significant parameter with the dependent variable, i.e. positive or negative, can be derived from the table. A negative coefficient value indicates a negative association, and vice versa.

The results indicate that in general, the road condition as measured by the PSR or percentage roads in poor condition [POOR] was not statistically associated with economic development as measured by either dependent variable. The percentage of paved roads [PAVED] was however significant in the case where was used by itself. The adjusted R^2s were very low.

The highway facility extent, measured by the 1980 total mileage, multi-lane mileage, and highway facility rating as specified earlier in this chapter, was highly significant and positively related in all cases where it was included in the model. Adjusted R^2s for regressions with mileage included as a variable was relatively high when compared to analyses where it was omitted from the model. Also, it should be noted that regressions where the 2-lane mileage was included in the model had in general a higher adjusted R^2 than regressions where just the multi-lane miles were part of the model. This indicated that the overall mileage in a county explained more of the variability in the change in total employment and total wage-income over the time period than just the multi-lane mileage. Another important factor is the coefficient values,

which indicated that the multi-lane mileage density had an effect of about seven to nine times that of the total mileage density, on the dependent variable measured by either the change in employment or the change in wage-income.

The highway expenditures between 1980 and 1988 were significant and positively associated with the response variable in the cases where it was the only variable in the model, albeit with a low adjusted R^2 of 0.11 and 0.05. When it was however included with the other highway variables of road condition and highway mileage, its relationship was significant only in some cases, and this relationship was constantly negative, indicating that highway expenditures had a negative association with economic development.

This is the opposite of the hypothesis, namely that higher highway expenditures will have a positive effect on the economic development in a county. The reason for this phenomenon is not clear. A possible explanation is that the time frame from 1980 to 1988 did not include significant new highway construction in some parts of Indiana, but rather localized construction. In this regard, it can be argued that in counties which were not growing economically, the road system had been deteriorating as well, and warranted more highway expenditures on its road system. Also, as was pointed out earlier in this chapter, the expenditure data had several limitations.

Manufacturing Sector

In Table 4.8, the results from the limited model with the change in manufacturing employment and wage-income from 1980 to 1988 were used separately as response variable, are shown. As with the total industrial sector, the condition of a county's highways were not significantly associated with economic development. The highway facility extent, also measured in three different ways, was again significant in all cases, but always with a negative association. The reason for this is not apparent. The manufacturing industries in Indiana experienced an absolute decline in employment of about 3% over the time period of the study. As seen in the regional analysis, these industries were typically located in more urbanized counties, such as Lake, with more extensive road networks per county area. The decline in manufacturing industries took place mostly in these counties, and there was therefore a negative relationship between highway mileage and economic development. In this case, it is obvious that the change in employment and wage-income did not come about as a result of highway infrastructure, but rather because of external circumstances, such as the decline of the manufacturing industry in the US as a whole over the last decade.

The variable of highway expenditures, by itself, was significant and negatively related. The reason for this

Table 4.8 Results from Limited Model Regressions for Manufacturing Sector

DEPENDENT VARIABLE : MANUFACTURING EMPLOYMENT CHANGE 1980-88

	INDEPENDENT VARIABLES			
ROAD VARIABLE	CONDITION	MILES	EXP	R**2
PSR		#	#	-0.01
POOR		#	#	-0.01
PAVED		#	#	0.01
1980 MILEAGE	#	(2,948)***	#	0.26
1980 > 2-LANE MILES	#	(30,190)***	#	0.32
HWY FAC RATING	#	(927)***	#	0.28
EXPENDITURES	#	#	-25***	0.22
PSR + 1980MIL + EXP		(1,974)***	-13*	0.27
PSR + >2LN + EXP		(24,480)***		0.32
PSR + HFR + EXP		(669)***		0.38
POOR + 1980MIL + EXP		(1,980)***	-12*	0.27
POOR + >2LN + EXP		(24,365)***		0.32
POOR + HFR + EXP		(672)***		0.28
PAVED + 1980MIL + EX		(2,141)***	-13*	0.28
PAVED + >2LN + EXP		(26,070)***		0.33
PAVED + HFR + EXP		(728)***	-11*	0.29

NOTES :
= VARIABLE NOT INCLUDED IN REGRESSION
COEFFICIENT VALUES FOR SIGNIFICANT VARIABLES ARE SHOWN
SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :
*** = 1% OR LESS
** = 5% OR LESS
* = 10% OR LESS

Table 4.8, continued

DEPENDENT VARIABLE : MANUFACTURING WAGE-INCOME CHANGE 1980-88

		INDEPENDENT VARIABLES		
ROAD VARIABLE	CONDITION	MILES	EXP	R**2
PSR		#	#	-0.01
POOR		#	#	-0.01
PAVED		#	#	0.01
1980 MILEAGE	#	(70)***	#	0.16
1980 > 2-LANE MILES	#	(773)***	#	0.23
HWY FAC RATING	#	(22)***	#	0.18
EXPENDITURES	#	#	-0.62***	0.15
PSR + 1980MIL + EXP		(42)*	-0.35*	0.17
PSR + >2LN + EXP		(641)***		0.22
PSR + HFR + EXP		(15)**		0.18
POOR + 1980MIL + EXP		(42)*	-0.35*	0.17
POOR + >2LN + EXP		(639)***		0.22
POOR + HFR + EXP		(15)**		0.18
PAVED + 1980MIL + EX		(47)**	-0.36*	0.17
PAVED + >2LN + EXP		(694)***		0.23
PAVED + HFR + EXP		(17)**		0.18

NOTES :
= VARIABLE NOT INCLUDED IN REGRESSION
COEFFICIENT VALUES FOR SIGNIFICANT VARIABLES ARE SHOWN
SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :
*** = 1% OR LESS
** = 5% OR LESS
* = 10% OR LESS

unexpected relationship could be the same as described in the previous section. It should also be noted that the adjusted R^2 were generally lower than in the total industrial sector case. In general, it appears that the limited state-wide model was not a good model for explaining changes in economic development in the manufacturing sector over the time period.

Service Sector

The final series of analyses with the limited model were done using the change in service employment and service wage-income from 1980 to 1988 separately as response variables. The results from these analyses are presented in Table 4.9.

It is evident from the table that the road condition was significant and positively associated with the response variable with low explanatory value when regressed individually, and marginal significance in some of the cases where it was included with other highway variables. As in the previous two sections, the highway facility extent was highly significant in all cases, with a positive association. As with the total industry case, the adjusted R^2s were higher in the cases where both two-lane and multi-lane highways were combined, compared to when just the multi-lane mileage was included. Coefficient values for multi-lane highway density were again about eight times the magnitude of the total road density parameters.

Table 4.9 Results from Limited Model Regressons for Service Sector

DEPENDENT VARIABLE : SERVICE EMPLOYMENT CHANGE 1980-88

	INDEPENDENT VARIABLES			
ROAD VARIABLE	CONDITION	MILES	EXP	R**2
PSR		#	#	-0.01
POOR		#	#	-0.01
PAVED	250***	#	#	0.11
1980 MILEAGE	#	12,959 ***	#	0.80
1980 > 2-LANE MILES	#	112,606 ***	#	0.72
HWY FAC RATING	#	3,960 ***	#	0.82
EXPENDITURES	#	#	77***	0.34
PSR + 1980MIL + EXP		13,836 ***		0.80
PSR + >2LN + EXP	679*	114,754 ***		0.72
PSR + HFR + EXP	459*	4,355 ***	-15*	0.82
POOR + 1980MIL + EXP		13,903 ***		0.80
POOR + >2LN + EXP		114,028 ***		0.72
POOR + HFR + EXP		4,373 ***	-16*	0.82
PAVED + 1980MIL + EX		13,901 ***		0.80
PAVED + >2LN + EXP		112,834 ***		0.71
PAVED + HFR + EXP		4,386 ***	-15*	0.82

NOTES :
= VARIABLE NOT INCLUDED IN REGRESSION
COEFFICIENT VALUES FOR SIGNIFICANT VARIABLES ARE SHOWN
SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :
*** = 1% OR LESS
** = 5% OR LESS
* = 10% OR LESS

Table 4.9, continued

DEPENDENT VARIABLE : SERVICE WAGE-INCOME CHANGE 1980-88

	INDEPENDENT VARIABLES			
ROAD VARIABLE	CONDITION	MILES	EXP	R**2
PSR		#	#	-0.01
POOR		#	#	-0.01
PAVED	5***	#	#	0.09
1980 MILEAGE	#	287 ***	#	0.77
1980 > 2-LANE MILES	#	2,479 ***	#	0.68
HWY FAC RATING	#	88 ***	#	0.78
EXPENDITURES	#	#	1.6***	0.30
PSR + 1980MIL + EXP		316 ***	-0.35*	0.78
PSR + >2LN + EXP	16.8*	2,605 ***		0.69
PSR + HFR + EXP	11.9**	99 ***	-0.47**	0.80
POOR + 1980MIL + EXP		318 ***	-0.37*	0.78
POOR + >2LN + EXP		2,585 ***		0.68
POOR + HFR + EXP		100 ***	-0.48**	0.80
PAVED + 1980MIL + EX		320 ***	-0.35*	0.77
PAVED + >2LN + EXP		2,582 ***		0.68
PAVED + HFR + EXP		101 ***	-0.46**	0.79

NOTES :
= VARIABLE NOT INCLUDED IN REGRESSION
COEFFICIENT VALUES FOR SIGNIFICANT VARIABLES ARE SHOWN
SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :
*** = 1% OR LESS
** = 5% OR LESS
* = 10% OR LESS

Highway expenditures followed approximately the same pattern as in the total industry sector, namely significant and positively related when it was the only independent variable in the model, but significant and negative when combined with the other variables. Reasons for this are the same as previously explained. It is important to note that the adjusted R^2s had a higher value than in the previous two sets of analyses, up to 0.82, indicating that this model is fairly good in that it explained a large part of the variance across Indiana counties in employment and wage-income changes in the service sector over the time period.

In summary, the limited state-wide model appeared to explain the variance in economic development in Indiana from 1980 to 1988 fairly well in the total industry and service sectors, but not very well in the manufacturing sector. Road condition appeared to have a significant and positive association with economic development in only a few cases, and highway expenditures were significant with a negative relationship in some regressions. Highway facility extent was however significant in all instances, with a positive association in the total industry and service sectors, and negative in the manufacturing sector. Multi-lane miles were also associated with much higher changes in economic development than the total highway system. In the next part of the analysis, the relationships and significance of these variables will be closely scrutinized.

The Comprehensive Model

In the comprehensive model, the same response variables were used as in the limited model, namely the change in employment and wage-income in the manufacturing, service and total industrial sectors, from 1980 to 1988. The highway infrastructure variables were also included in the same way, namely each individually, and in combination to analyze different impacts. The other variables that were postulated to be of importance were added in these analyses to form the complete model. The comprehensive state-wide model was defined as :

$$Y = X'B + e$$

where Y = dependent or response variable, measured as the change in total, manufacturing or service employment or wage-income from 1980 to 1988 in a county;

B = a vector of regression parameters, associated with the independent variables;

e = a vector of errors;

X = the vector of independent variables, consisting of

COND = the road condition variable, defined alternatively as the average weighted road condition of the state highway system in a county in 1985 [PSR], the percentage of roads with a PSR

of 2.5 or less in a county in 1985 [POOR], and the percentage of the total highway system that was paved in a county in 1983 [PAVED];

MILES = the highway facility variable, defined alternatively as the total mileage, the multi-lane mileage, and the highway facility rating in 1980, per area in a county;

EXP = the total highway expenditures in a county, from 1980 to 1988 in 1988 dollars, per area of the county;

ELEC = the industrial or commercial electric rate in a county in 1980, as applicable, in dollars per kW-hour;

WATER = the water availability in a county, on a scale from 2 to 7;

APT = the straight-line distance from a county to the nearest large airport, in miles;

COLL = the percentage of college graduates in a county, in 1980;

MSA = the distance from a county to the nearest metropolitan statistical area, in miles;

RECR = the acreage of federal, state and local public recreational facilities in a county in 1988;

TAXRT = the net property tax rate in a county in 1980;

WAGE = the average wage rate for the total industry, manufacturing or service sectors in a county in 1980, as applicable, and

AGGL = the agglomeration variable, measured as the manufacturing and/or service sector employment in a county in 1980, as applicable.

Various forms of the agglomeration variable were included in different regressions, to perform a sensitivity analysis with respect to this variable. With all the other variables the same, the agglomeration variable was varied as follows:

- no agglomeration variable;
- only manufacturing employment in a county in 1980;
- only service employment in a county in 1980;
- manufacturing employment and service employment in a county in 1980.

This variation would indicate what impact the variable had on the model. The various sets of analyses with the comprehensive model will now be discussed.

Total Employment

Table 4.10 shows the coefficient values and p-value range of highway variables that were significant, and only the p-value range of other significant variables, as well as the adjusted R^2 for all the regressions that were done using the total employment change and total wage income change between 1980 and 1988 separately as response variables. The first column in

Table 4.10 Results from Comprehensive Model Regressions for Total Employment Sector

DEPENDENT VARIABLE : TOTAL EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SVCEMP	R**2
PSR	NONE		#	#	-**		-**	***					#	#	0.26
	MFG		#	#	-***			***			-***	-***	***	#	0.65
	SVC		#	#	-*			***			-***	-*	#	***	0.72
	MFG + SVC		#	#				***			-***	-*		***	0.72
POOR	NONE		#		-**		-**	***					#	#	0.26
	MFG		#		-**			***			-***	-***	***	#	0.65
	SVC		#					***			-***	-*	#	***	0.72
	MFG + SVC		#					***			-***			***	0.72
PAVED	NONE		#		-**		-**	***					#	#	0.26
	MFG		#		-**			***			-***	-***	***	#	0.65
	SVC		#					***			-***	-*	#	***	0.72
	MFG + SVC		#					***			-***			***	0.72
1980 MILES	NONE	#	9,231 ***	#	-*			***			-***	-**	#	#	0.66
	MFG	#	5,403 ***	#	-**			***			-***	-***	***	#	0.69
	SVC	#		#				***			-***	-**	#	***	0.73
	MFG + SVC	#		#				***			-***	-*		***	0.72
1980 >2LN MILES	NONE	#	69,162 ***	#	-***			***			-***	-**	#	#	0.54
	MFG	#	26,519 **	#	-***			***			-***	-***	***	#	0.67
	SVC	#		#				***			-***	-*	#	***	0.72
	MFG + SVC	#		#				***			-***			***	0.72
HIGHWAY FACILITY RATING	NONE	#	2,822 ***	#	-**			***			-***	-**	#	#	0.66
	MFG	#	1,673 ***	#	-**			***			-***	-***	***	#	0.70
	SVC	#		#	-*			***			-***	-**	#	***	0.72
	MFG + SVC	#		#				***			-***	-*		***	0.72
EXPENDITURE	NONE	#	#	21 **	-**		-*	***					#	#	0.29
	MFG	#	#		-**			***			-***	-***	***	#	0.65
	SVC	#	#	-15 **			-*	***			-***	-*	#	***	0.74
	MFG + SVC	#	#	-15 **			-*	***			-***			***	0.73
PSR + BOMIL + EXP	NONE		10,393 ***	-18 **	-*			***			-***	-**	#	#	0.68
	MFG		6,554 ***	-16 **	-**			***			-***	-***	***	#	0.71
	SVC		3,397 **	-18 **	-*			***			-***	-**	#	***	0.75
	MFG + SVC		3,419 **	-19 **				***			-***	-*		***	0.74

Table 4.10, continued

DEPENDENT VARIABLE : TOTAL EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR CONDITION	MILES	EXP	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
PSR + >2LN	NONE	75,563 ***		-***			***			-***	-**	#	#	0.54
+ EXP	MFG	33,056 ***	-13 *	-***			***			-***	-***	***	#	0.68
	SVC		-15 **			-*	***			-***	-*	#	***	0.73
	MFG + SVC		-15 **			-*	***			-***			***	0.73
PSR + HFR	NONE	3,230 ***	-20 **	-**			***			-***	-**	#	#	0.68
+ EXP	MFG	2,092 ***	-18 **	-***			***			-***	-***	***	#	0.71
	SVC	1,022 *	-19 **	-*			***			-***	-**	#	***	0.74
	MFG + SVC	1,013 *	-19 **	-*			***			-***	-*		***	0.74
POOR + 80MI	NONE	10,473 ***	-18 **	-*			***			-***	-**	#	#	0.68
+ EXP	MFG	6,691 ***	-17 **	-**			***			-***	-***	***	#	0.70
	SVC	3,414 *	-18 **				***			-***	-**	#	***	0.74
	MFG + SVC	3,444 *	-19 **				***			-***	-*		***	0.74
POOR + >2LN	NONE	75,751 ***		-***			***			-***	-**	#	#	0.54
+ EXP	MFG	33,322 ***	-13 *	-***			***			-***	-***	***	#	0.67
	SVC		-15 **			-*	***			-***	-*	#	***	0.73
	MFG + SVC		-15 **			-*	***			-***			***	0.73
POOR + HFR	NONE	3,254 ***	-20 **	-**			***			-***	-**	#	#	0.68
+ EXP	MFG	2,138 ***	-18 **	-**			***			-***	-***	***	#	0.71
	SVC	1,031 *	-19 **	-*			***			-***	-**	#	***	0.74
	MFG + SVC	1,020 *	-19 **				***			-***	-*		***	0.74
PAVED+80MIL	NONE	10,386 ***	-18 **	-*			***			-***	-**	#	#	0.67
+ EXP	MFG	6,621 ***	-17 **	-**			***			-***	-***	***	#	0.70
	SVC	3,341 **	-19 **				***			-***	-**	#	***	0.74
	MFG + SVC	3,353 **	-19 **				***			-***	-*		***	0.74
PAVED+>2LN	NONE	75,422 ***		-***			**			-***	-**	#	#	0.54
+ EXP	MFG	33,617 ***	-14 *	-***			***			-***	-***	***	#	0.67
	SVC		-15 **				***			-***	-*	#	***	0.73
	MFG + SVC		-15 **				***			-***			***	0.73
PAVED + HFR	NONE	3,229 ***	-20 **	-**			***			-***	-**	#	#	0.68
+ EXP	MFG	2,114 ***	-18 **	-**			***			-***	-***	***	#	0.71
	SVC	1,007 *	-19 **	-*			***			-***	-**	#	***	0.74
	MFG + SVC	990 *	-19 ***				***			-***	-*		***	0.74

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT VARIABLES ARE SHOWN

*** = PARAMETER WAS DIFFERENT FROM 0 AT 1% LEVEL OF SIGNIFICANCE OR LESS

** = PARAMETER WAS DIFFERENT FROM 0 AT 5% LEVEL OF SIGNIFICANCE OR LESS

* = PARAMETER WAS DIFFERENT FROM 0 AT 10% LEVEL OF SIGNIFICANCE OR LESS

Table 4.10, continued

DEPENDENT VARIABLE : TOTAL WAGE-INCOME CHANGE 1980-88 — INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
PSR	NONE		‡	‡	-***		-*	***			-***	‡	‡	0.23
	MFG		‡	‡	-**			***			-***	***	‡	0.48
	SVC		‡	‡	-**			***			-***	‡	***	0.63
	MFG + SVC		‡	‡	-*			**			-***	-***	***	0.66
POOR	NONE		‡	‡	-***		-*	***			-**	‡	‡	0.23
	MFG		‡	‡	-**			***			-***	***	‡	0.47
	SVC		‡	‡	-**			***			-***	‡	***	0.63
	MFG + SVC		‡	‡				**			-***	-***	***	0.66
PAVED	NONE		‡	‡	-***			**			-**	‡	‡	0.23
	MFG		‡	‡	-**			***			-***	***	‡	0.47
	SVC		‡	‡	-**			***			-***	‡	***	0.63
	MFG + SVC		‡	‡	-*			**			-***	-***	***	0.66
1980 MILES	NONE	‡	237 ***	‡	-**			***	*		-***	‡	‡	0.60
	MFG	‡	230 ***	‡	-**			***	*		-***		‡	0.59
	SVC	‡	88 *	‡	-**			***			-***	‡	***	0.64
	MFG + SVC	‡	97 *	‡	-*			***			-***	-***	***	0.67
1980 >2LN MILES	NONE	‡	1,709 ***	‡	-***			**			-***	‡	‡	0.47
	MFG	‡	988 ***	‡	-***			***			-***	***	‡	0.52
	SVC	‡		‡				***			-***	‡	***	0.63
	MFG + SVC	‡		‡				**			-***	-***	***	0.66
HIGHWAY FACILITY RATING	NONE	‡	72 ***	‡	-**			***	*		-***	‡	‡	0.60
	MFG	‡	70 ***	‡	-**			***	*		-***		‡	0.59
	SVC	‡		‡	-**			***			-***	‡	***	0.63
	MFG + SVC	‡		‡	-*			**			-***	-***	***	0.67
EXPENDITURE	NONE	‡	‡	0.54 *	-**			***			-***	‡	‡	0.26
	MFG	‡	‡		-**			***			-***	***	‡	0.47
	SVC	‡	‡	-0.37 *	-**			***			-***	‡	***	0.64
	MFG + SVC	‡	‡	-0.43 **				**			-***	-***	***	0.68
PSR + 80MIL + EXP	NONE		269 ***	-0.49 **	-**			***	*		-***	‡	‡	0.61
	MFG		265 ***	-0.49 **	-**			***	*		-***		‡	0.60
	SVC		118 **	-0.50 **	-**			***			-***	‡	***	0.65
	MFG + SVC		133 **	-0.58 **				***			-***	-***	***	0.70

Table 4.10, continued

DEPENDENT VARIABLE : TOTAL WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
PSR + >2LN	NONE		1,865 ***		-***			**			-***	#	#	0.47
+ EXP	MFG		1,139 ***		-***			***			-***	***	#	0.51
	SVC				-*			***			-***	#	***	0.63
	MFG + SVC			-0.40 *				**			-***	-***	***	0.67
PSR + HFR	NONE		83 ***	-0.53 **	-***			***	*		-***	#	#	0.61
+ EXP	MFG		83 ***	-0.53 **	-**			***	*		-***		#	0.61
	SVC		35 **	-0.51 **	-**			***			-***	#	***	0.65
	MFG + SVC		37 **	-0.57 **	-*			**			-***	-***	***	0.69
POOR + 80MI	NONE		272 ***	-0.49 ***	-**			***	*		-***	#	#	0.61
+ EXP	MFG		274 ***	-0.50 ***	-**			***	*		-***		#	0.61
	SVC		123 **	-0.50 **	-**			***			-***	#	***	0.65
	MFG + SVC		139 **	-0.58 **				**			-***	-***	***	0.70
POOR + >2LN	NONE		1,876 ***		-***			**			-***	#	#	0.47
+ EXP	MFG		1,157 ***		-***			***			-***	***	#	0.51
	SVC				-*			***			-***	#	***	0.64
	MFG + SVC			-0.40 *				**			-***	-***	***	0.67
POOR + HFR	NONE		84 ***	-0.54 **	-***			***	*		-***	#	#	0.61
+ EXP	MFG		86 ***	-0.55 **	-**			***	*		-***		#	0.61
	SVC		37 **	-0.51 **	-**			***			-***	#	***	0.65
	MFG + SVC		39 **	-0.58 ***	-*			**			-***	-***	***	0.69
PAVED+80MIL	NONE		269 ***	-0.49 **	-**			***	*		-***	#	#	0.61
+ EXP	MFG		266 ***	-0.49 **	-**			***	*		-***		#	0.60
	SVC		116 **	-0.50 **	-**			***			-***	#	***	0.65
	MFG + SVC		129 **	-0.59 ***				**			-***	-***	***	0.70
PAVED+>2LN	NONE		1,859 ***		-***			**			-***	#	#	0.47
+ EXP	MFG		1,147 ***		-***			***			-***	***	#	0.51
	SVC			-0.39 *	-*			***			-***	#	***	0.63
	MFG + SVC			-0.42 *				**			-***	-***	***	0.67
PAVED + HFR	NONE		83 ***	-0.54 **	-***			***	*		-***	#	#	0.61
+ EXP	MFG		83 ***	-0.54 **	-**			***	*		-***		#	0.61
	SVC		35 *	-0.51 **	-**			***			-***	#	***	0.65
	MFG + SVC		36 **	-0.58 ***	-**			**			-***	-***	***	0.69

NOTES :
= VARIABLE NOT INCLUDED IN REGRESSION
COEFFICIENT VALUES FOR SIGNIFICANT VARIABLES ARE SHOWN
*** = PARAMETER WAS DIFFERENT FROM 0 AT 1% LEVEL OF SIGNIFICANCE OR LESS
** = PARAMETER WAS DIFFERENT FROM 0 AT 5% LEVEL OF SIGNIFICANCE OR LESS
* = PARAMETER WAS DIFFERENT FROM 0 AT 10% LEVEL OF SIGNIFICANCE OR LESS

the table shows the highway variables that were used in a specific regression, the second column the agglomeration variable that was used, with the rest of the columns indicating all the variables in the model and their significance or not. The estimates of the coefficients of the highway variables, where these were significant, are also given. The adjusted R^2 for a specific regression is given in the right hand column.

The following general observations can be made concerning these results :

- The PSR, POOR, and PAVED road condition variables were not significant in any of the regressions, whether included individually or in combination with other highway variables.
- The highway facility extent variable, as measured in different ways, was significant in most regressions. Similar to the limited model's results, the mileage when including the two-lane miles was significant in more cases than when just the multi-lane mileage was used. The estimates of the coefficients also displayed similar behavior as in the limited model, namely multi-lane density having on average 7 times the effect of the total mileage. Another effect of the sensitivity analysis was that with a specific configuration of highway variables, the coefficient decreased rapidly. This can be attributed to the inclusion of other significant variables in the model, which reduce the impact on the dependent variable attributed to the highway variable.

- The highway expenditures were significant in most cases, and had a negative association with the response variable. This behavior is similar to that which had been perceived in the limited model, and it is presumed that the same reasons are applicable. Expenditure coefficients did not vary as much as the mileage coefficients, but had approximately constant values.

- Concerning the other variables, it can be seen that the percentage college graduates and the property tax rates were significant in almost all cases, with the expected associations, positive and negative respectively. This implies that a higher percentage of college graduates and a lower property tax rate in a county were associated with an increase in economic development. Of the other variables in the model, the electric utility rate and the wage rate (only in the total employment model) were significant in several cases.

- The agglomeration variable/s had different behaviors with the two response variables. When the change in employment was the dependent variable, the manufacturing and service employment in 1980 was significant when included individually. When included together, just service employment was significant. This implies that the presence of service industries in a county in the base year had a more significant impact on economic development than the manufacturing employment. For the wage-income model this behavior was different. When just the manufacturing employment was included, it was mostly significant and positively, and the

service employment was always significant and positive when on its own in the model. When combined, the manufacturing employment association was always negative and significant, while for service employment it was positive and significant. This could indicate that wage-income increased in counties where lower manufacturing but higher service employment was present in the base year.

- Some important conclusions can be made concerning the different models, as indicated by the adjusted R^2. Firstly, the increase in this parameter when the agglomeration variables were introduced into the model indicates better explanation of response variable behavior due to these variables. The increase varied in magnitude, being slightly higher when highway variables were included separately than when they were combined. Secondly, in the employment model, the highest adjusted R^2 was achieved when just the service employment in the base year was used as agglomeration variable. The highest value of 0.75 was obtained when all three highway variables were included in the model. In the wage-income model, the adjusted R^2 was the highest when the manufacturing as well as service employment were used as agglomeration variables, with values of 0.70.

- In general, the highway parameters' behavior were the same as in the limited model, namely road condition not significant, and mileage and expenditures significant with positive and negative association respectively. The coefficient of determination did however show a considerable

increase, from a highest value of 0.47 previously, to 0.75 in the comprehensive model. This implies that more of the variance in the economic development across counties was explained in the comprehensive model by including additional explanatory variables. The highway parameters had a more or less consistent behavior in both models. The caveat involved is, however, that the agglomeration variable could have captured the effect of heteroscedasticity in the model, an issue that will be addressed later in this chapter.

Manufacturing Sector

The next series of regressions were performed by using the manufacturing employment and wage-income change per county separately as response variables, and the results are presented in Table 4.11. The following observations can be made concerning these results :

- The road condition as measured by the average PSR, the percentage of roads in poor condition, or the paved mileage, was not significant in any of the models.
- The highway mileage variables were significant only in some cases. In general the parameter had a negative association, but in the wage-income model the 1980 mileage and highway facility rating were positive in all cases where these variables were significant. This variation appears to be associated with the other highway variables in a model, as

Table 4.11 Results from Comprehensive Model Regressions for Manufacturing Employment Sector

DEPENDENT VARIABLE : MANUFACTURING EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
PSR	*		▮	▮							-***		▮	▮	0.39
	MFG		▮	▮							-***		-***	▮	0.47
	SVC		▮	▮			-*	**			-***		▮	-***	0.50
	MFG + SVC		▮	▮			-*	**			-***			-**	0.49
POOR	*		▮	▮							-***		▮	▮	0.38
	MFG		▮	▮							-***		-***	▮	0.47
	SVC		▮	▮			-*	**			-***		▮	-***	0.50
	MFG + SVC		▮	▮			-*	**			-***			-**	0.49
PAVED	*		▮	▮							-***		▮	▮	0.37
	MFG		▮	▮							-***		-***	▮	0.47
	SVC		▮	▮				*			-***		▮	-***	0.49
	MFG + SVC		▮	▮				*			-***			-**	0.49
1980 MILES	*	▮	(2,193)***	▮							-***		▮	▮	0.45
	MFG	▮		▮							-***		-**	▮	0.47
	SVC	▮		▮				**			-***		▮	-***	0.50
	MFG + SVC	▮		▮				**			-***			-**	0.49
1980 >2LN MILES	*	▮	(25,302)***	▮			-*	**			-***		▮	▮	0.49
	MFG	▮	(18,146)**	▮			-*	**			-***			▮	0.50
	SVC	▮		▮			-**	**			-***		▮	-*	0.51
	MFG + SVC	▮		▮			-**	**			-***				0.50
HIGHWAY FACILITY RATING	*	▮	(735)***	▮				*			-***		▮	▮	0.46
	MFG	▮		▮							-***		-*	▮	0.47
	SVC	▮		▮				**			-***		▮	-**	0.49
	MFG + SVC	▮		▮				**			-***			-*	0.49
EXPENDITURE	*	▮	▮	-16 ***							-***		▮	▮	0.44
	MFG	▮	▮	-10 *			-*				-***		-***	▮	0.49
	SVC	▮	▮				-*	**			-***		▮	-***	0.50
	MFG + SVC	▮	▮				-*	**			-***				0.50
PSR & 80MIL + EXP	*		(1,477) *	-10 *			-*	*			-***		▮	▮	0.46
	MFG			-11 *			-*	*			-***		-**	▮	0.48
	SVC			-10 *			-*	**			-***	-*	▮	-***	0.51
	MFG + SVC			-10 *			-*	**			-***	-*		-**	0.51

Table 4.11, continued

DEPENDENT VARIABLE : MANUFACTURING EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR CONDITION	MILES	EXP	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SVCEMP	R**2
PSR + >2LN	*	(21,436)***				-**	**			-***		#	#	0.50
+ EXP	MFG	(15,976)**				-**	**			-***			#	0.51
	SVC					-**	**			-***		#		0.51
	MFG + SVC					-**	**			-***				0.50
PSR + HFR	*	(537)**				-**	*			-***		#	#	0.47
+ EXP	MFG		-10 *			-*	*			-***		-*	#	0.48
	SVC		-10 *			-*	**			-***	-*	#	-**	0.51
	MFG + SVC		-10 *			-*	**			-***	-*		-**	0.50
POOR + 80MI	*	(1,623)**	-9.8 *			-*				-***		#	#	0.46
+ EXP	MFG		-10.4 *				*			-***		-*	#	0.48
	SVC		-10 *			-*	**			-***		#	-***	0.51
	MFG + SVC		-9.6 *			-*	**			-***			-**	0.51
POOR + >2LN	*	(21,800)***				-**	**			-***		#	#	0.50
+ EXP	MFG	(16,018)**				-**	**			-***			#	0.51
	SVC					-**	**			-***		#		0.51
	MFG + SVC					-**	**			-***				0.51
POOR + HFR	*	(519)**				-*	*			-***		#	#	0.47
+ EXP	MFG					-*	*			-***			#	0.48
	SVC		-9.4 *			-*	**			-***		#	-**	0.50
	MFG + SVC					-*	**			-***			-*	0.50
PAVED+80MIL	*	(1,605)**	-10.3 *							-***		#	#	0.47
+ EXP	MFG		-10.9 *							-***		-**	#	0.48
	SVC		-10.1 *				*			-***	-*	#	-***	0.51
	MFG + SVC		-10.1 *				*			-***			-**	0.50
PAVED+>2LN	*	(21,983)***				-*	*			-***		#	#	0.50
+ EXP	MFG	(15,597)**				-*	*			-***			#	0.51
	SVC					-*	*			-***		#		0.51
	MFG + SVC					-*	*			-***				0.50
PAVED + HFR	*	(575)**								-***		#	#	0.47
+ EXP	MFG		-9.9 *							-***		-*	#	0.48
	SVC		-9.8 *				*			-***	-*	#	-**	0.50
	MFG + SVC		-9.7 *				*			-***			-*	0.50

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT VARIABLES ARE SHOWN

*** = PARAMETER WAS DIFFERENT FROM 0 AT 1% LEVEL OF SIGNIFICANCE OR LESS

** = PARAMETER WAS DIFFERENT FROM 0 AT 5% LEVEL OF SIGNIFICANCE OR LESS

* = PARAMETER WAS DIFFERENT FROM 0 AT 10% LEVEL OF SIGNIFICANCE OR LESS

Table 4.11, continued

DEPENDENT VARIABLE : MANUFACTURING WAGE-INCOME CHANGE 1980-88 IINDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
PSR	*		!	!							-***	!	!	0.40
	MFG		!	!				*			-***	-***	!	0.46
	SVC		!	!				*			-***	!	-**	0.43
	MFG + SVC		!	!							-***	-*		0.45
POOR	*		!	!							-***	!	!	0.40
	MFG		!	!							-***	-***	!	0.46
	SVC		!	!				*			-***	!	-**	0.44
	MFG + SVC		!	!							-***	-*		0.45
PAVED	*		!	!							-***	!	!	0.40
	MFG		!	!							-***	-***	!	0.46
	SVC		!	!			*				-***	!	-**	0.43
	MFG + SVC		!	!							-***	-**		0.46
1980 MILES	*	!		!							-***	!	!	0.41
	MFG	!	62 *	!							-***	-***	!	0.48
	SVC	!	73 *	!				*			-***	!	-***	0.45
	MFG + SVC	!	72 *	!							-***	-**		0.47
1980 >2LN MILES	*	!	(509)***	!				**			-***	!	!	0.45
	MFG	!		!				*			-***		!	0.46
	SVC	!		!				**			-***	!		0.45
	MFG + SVC	!	(513) *	!				*			-***	-**	*	0.48
HIGHWAY FACILITY RATING	*	!		!				*			-***	!	!	0.42
	MFG	!		!							-***	-***	!	0.47
	SVC	!		!				**			-***	!	-**	0.44
	MFG + SVC	!		!							-***	-*		0.46
EXPENDITURE	*	!	!	-0.27 *							-***	!	!	0.42
	MFG	!	!					*			-***	-***	!	0.46
	SVC	!	!					*			-***	!	-*	0.44
	MFG + SVC	!	!								-***	-**		0.46
PSR + 80MIL + EXP	*										-***	!	!	0.41
	MFG		80 **								-***	-***	!	0.48
	SVC		86 **		-*			**			-***	!	-***	0.45
	MFG + SVC		87 **								-***	-**		0.47

Table 4.11, continued

DEPENDENT VARIABLE : MANUFACTURING WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	MANEMP	SVCEMP	R**2
PSR + >2LN	*		(474)**					**			-***	#	#	0.45
+ EXP	MFG							*			-***		#	0.45
	SVC							**			-***	#		0.44
	MFG + SVC		(498) *					*			-***	-**	*	0.47
PSR + HFR	*							*			-***	#	#	0.41
+ EXP	MFG		19 *								-***	-***	#	0.47
	SVC							*			-***	#	-**	0.44
	MFG + SVC										-***	-**		0.46
POOR + 80MI	*										-***	#	#	0.41
+ EXP	MFG		79 **								-***	-***	#	0.48
	SVC		84 *					*			-***	#	-***	0.45
	MFG + SVC		87 **								-***	-**		0.47
POOR + >2LN	*		(477)**					**			-***	#	#	0.45
+ EXP	MFG							*			-***		#	0.45
	SVC							**			-***	#		0.44
	MFG + SVC		(492) *					*			-***	-**	*	0.47
POOR + HFR	*							*			-***	#	#	0.41
+ EXP	MFG		19 *								-***	-***	#	0.46
	SVC							*			-***	#	-**	0.44
	MFG + SVC										-***	-**		0.46
PAVED+80MIL	*										-***	#	#	0.41
+ EXP	MFG		79 **								-***	-***	#	0.48
	SVC		85 *					*			-***	#	-***	0.45
	MFG + SVC		84 *								-***	-**		0.47
PAVED+>2LN	*		(484)**					*			-***	#	#	0.44
+ EXP	MFG										-***		#	0.45
	SVC							*			-***	#		0.44
	MFG + SVC		(528) *								-***	-**	*	0.47
PAVED + HFR	*										-***	#	#	0.41
+ EXP	MFG		19 *								-***	-***	#	0.47
	SVC							*			-***	#	-**	0.44
	MFG + SVC										-***	-**		0.46

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT VARIABLES ARE SHOWN

*** = PARAMETER WAS DIFFERENT FROM 0 AT 1% LEVEL OF SIGNIFICANCE OR LESS

** = PARAMETER WAS DIFFERENT FROM 0 AT 5% LEVEL OF SIGNIFICANCE OR LESS

* = PARAMETER WAS DIFFERENT FROM 0 AT 10% LEVEL OF SIGNIFICANCE OR LESS

well as the specific agglomeration variable/s that were used. A possible explanation is that counties that had a high multi-lane mileage, such as Lake, had a significant decrease in manufacturing employment. The negative association is consistent with the results from the limited model. In most cases, the estimated coefficients displayed a behavior similar to that in the total industry model, namely multi-lane coefficients having a much higher order value, and a decrease in value with the addition of agglomeration variables. The exception to this was in the wage-income model, where the values within a specific highway variable configuration stayed more or less constant with the addition of agglomeration variables.

- Highway expenditures were significant with negative association only in the employment model, the most frequent occurrence being when the total road mileage or highway facility rating was the mileage variable. The negative association is consistent with previous behavior, both in the manufacturing limited model and all other models. Coefficient values also stayed more or less constant.
- Other consistently significant variables were the property tax rate and the percentage of college graduates with both response variables in the model, and the distance to a large airport in several cases in the employment model.
- The agglomeration variable had a negative association in almost all cases in both models. This can possibly be explained by the fact that manufacturing employment declined

overall, and mostly in counties which had higher levels of manufacturing and service employment in 1980. The inclusion of this variable did however tend to increase the R^2 in most cases, by between 0.01 and 0.11. This increase was not as significant as in models with other response variables. In the wage-income model, it is interesting to note that the significant variable in the case where both agglomeration variables were included in the model, differs from the employment model, indicating that base-year service employment was significantly associated with changes in manufacturing employment, and base-year manufacturing employment associated with changes in manufacturing wage-income, in almost all cases.

- In this model, the adjusted R^2 stayed fairly constant in most cases, regardless of the configuration of highway variables or the inclusion of different agglomeration variables. In the employment model, this value was on average close to 0.50, and slightly lower in the wage-income model. This indicates that these two models are not very dependable for forecasting purposes, in that at most half of the variance in the response variable was explained by the explanatory variables, regardless of which variables or combinations of variables were used. It should however be noted that the inclusion of other variables increased the adjusted R^2 from a previously highest level of 0.38 in the limited model.

Service Sector

The next series of analyses were performed by changing the dependent variables to service employment and wage-income change between 1980 and 1988 separately. Table 4.12 shows the results from the two sets of regressions that were done. Results can be summarized as follows :

- The road condition parameter, when measured by average PSR in a county (PSR), was positive and marginally significant in several cases only in the employment model, when this variable was used in conjunction with other highway variables and agglomeration variables. The percentage of roads in a poor condition (POOR) was significant and negative by association in several cases, consistent with the stated hypothesis. The percentage of paved roads (PAVED) was not significant in any of the models.
- The highway facility extent was highly significant and positively associated in almost all cases in both models. This is consistent with behavior of the variable in the limited model for the service sector, and statistically confirms the supposition that highway facility extent affects economic development. Coefficient value behavior was consistent with previous patterns, namely multi-lane coefficients having on average eight times the size of total mileage parameters, and rapid decrease of values within a fixed set of highway parameters, with the addition of agglomeration variables.

Table 4.12 Results from Comprehensive Model Regressions for Service Employment Sector

DEPENDENT VARIABLE : SERVICE EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SVCEMP	R**2
PSR	+		▮	▮	-+			+			+++	+++	▮	▮	0.39
	MFG		▮	▮	-+			+++			-+++		+++	▮	0.85
	SVC		▮	▮				+++			-+++	-+++	▮	+++	0.98
	MFG + SVC		▮	▮				+++			-+++	-++	-++	+++	0.98
POOR	+		▮	▮	-+						+++	+++	▮	▮	0.39
	MFG		▮	▮	-+			+++			-+++		+++	▮	0.85
	SVC	-33 +	▮	▮				+++			-+++	-++	▮	+++	0.98
	MFG + SVC	-34 +	▮	▮				+++			-+++	-++	-++	+++	0.98
PAVED	+		▮	▮	-+						+++	+++	▮	▮	0.40
	MFG		▮	▮	-+			+++			-+++		+++	▮	0.85
	SVC		▮	▮				+++			-+++	-++	▮	-+++	0.98
	MFG + SVC		▮	▮				+++			-+++	-++	-++	+++	0.98
1980 MILES	+	▮	14,489 +++	▮				+++	++	++	-++		▮	▮	0.84
	MFG	▮	7,729 +++	▮				+++	++		-+++		+++	▮	0.90
	SVC	▮		▮				+++	+		-+++	-+++	▮	+++	0.98
	MFG + SVC	▮		▮				+++			-+++	-++	-++	+++	0.98
1980 >2LN MILES	+	▮	117,598 +++	▮	-+++		+	++					▮	▮	0.77
	MFG	▮	58,239 +++	▮	-+++			+++	++		-+++	-+	+++	▮	0.91
	SVC	▮		▮				+++			-+++	-+++	▮	+++	0.98
	MFG + SVC	▮		▮				+++			-+++	-++	-+	+++	0.98
HIGHWAY FACILITY RATING	+	▮	4,519 +++	▮				+++	++	++	-++		▮	▮	0.86
	MFG	▮	2,600 +++	▮	-+			+++	+++		-+++	-+	+++	▮	0.91
	SVC	▮		▮				+++	+		-+++	-++	▮	+++	0.98
	MFG + SVC	▮		▮				+++			-+++	-++	-++	+++	0.98
EXPENDITURE	+	▮	▮	41 +++	-+			+			+	-++	▮	▮	0.46
	MFG	▮	▮		-+			+++			-+++		+++	▮	0.85
	SVC	▮	▮	-8 +++				+++			-+++	-++	▮	+++	0.98
	MFG + SVC	▮	▮	-9 +++				+++			-+++	-++	-+++	+++	0.98
PSR + 80MIL + EXP	+		15,086 +++					+++	++	++	-+		▮	▮	0.84
	MFG		8,213 +++					+++	++		-+++		+++	▮	0.90
	SVC	155 +	1,474 ++	-10 +++				+++			-+++	-+++	▮	+++	0.98
	MFG + SVC	164 +	1,596 +++	-11 +++				+++			-+++	-++	-+++	+++	0.99

Table 4.12, continued

DEPENDENT VARIABLE : SERVICE EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
PSR + >2LN	*		130,905 ***		-***		*	*					#	#	0.77
+ EXP	MFG		62,260 ***		-***			***	**		-***	-*	***	#	0.91
	SVC	166 *	12,684 ***	-10 ***				***			-***	-***	#	***	0.99
	MFG + SVC	168 *	10,734 **	-10 ***				***			-***	-***	-**	***	0.99
PSR + HFR	*		4,784 ***	-13 *				***	**	**	-**		#	#	0.86
+ EXP	MFG		2,837 ***		-*			***	**		-***	-*	***	#	0.91
	SVC	162 *	576 ***	-10 ***				***	*		-***	-***	#	***	0.99
	MFG + SVC	170 *	585 ***	-11 ***				***			-***	-**	-***	***	0.99
POOR + 80MI	*	-127 **	15,327 ***					***	**	***			#	#	0.85
+ EXP	MFG	-80 *	8,589 ***					***	***	**	-***		***	#	0.90
	SVC	-42 **	1,713 **	-9.9 ***				***	*		-***	-***	#	***	0.99
	MFG + SVC	-44 **	1,847 ***	-10.8 ***				***			-***	-**	-***	***	0.99
POOR + >2LN	*		121,445 ***		-***		*	*					#	#	0.77
+ EXP	MFG		62,855 ***		-***			***	**		-***		***	#	0.91
	SVC	-38 **	13,150 ***	-10.1 ***				***			-***	-***	#	***	0.99
	MFG + SVC	-38 **	11,212 ***	-10.4 ***				***			-***	-**	-**	***	0.99
POOR + HFR	*	-128 **	4,855 ***	-13.6 *	-*			***	**	**	-**		#	#	0.87
+ EXP	MFG	-86 **	958 ***		-*			***	***	**	-***		***	#	0.91
	SVC	-45 **	659 ***	-10.5 ***				***			-***	-***	#	***	0.99
	MFG + SVC	-46 ***	671 ***	-11.2 ***				***			-***	-**	-***	***	0.99
PAVED+80MIL	*		15,102 ***					***	**	**	-*		#	#	0.84
+ EXP	MFG		8,209 ***					***	**		-***		***	#	0.90
	SVC		1,361 **	-9.7 ***				***	*		-***	-**	#	***	0.98
	MFG + SVC		1,460 ***	-10.8 ***				***			-***	-**	-***	***	0.99
PAVED+>2LN	*		120,201 ***		-***			*					#	#	0.77
+ EXP	MFG		61,770 ***		-***			***	**		-***	-*	***	#	0.90
	SVC		11,751 ***	-10.3 ***				***			-***	-**	#	***	0.98
	MFG + SVC		9,604 **	-10.6 ***				***			-***	-**	-**	***	0.99
PAVED + HFR	*		4,787 ***	-12.7 *				***	**	**	-**		#	#	0.86
+ EXP	MFG		2,830 ***		-*			***	***		-***		***	#	0.91
	SVC		534 ***	-10.4 ***				***	*		-***	-**	#	***	0.98
	MFG + SVC		535 ***	-11.1 ***				***			-***	-**	-***	***	0.99

NOTES :

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** = PARAMETER WAS DIFFERENT FROM 0 AT 5% LEVEL OF SIGNIFICANCE OR LESS

* = PARAMETER WAS DIFFERENT FROM 0 AT 10% LEVEL OF SIGNIFICANCE OR LESS

Table 4.12, continued

DEPENDENT VARIABLE : SERVICE WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
PSR	+		#	#	-*			**			***	#	#	0.29
	MFG		#	#	-**			***	*		-***	***	#	0.81
	SVC		#	#				***	**		-***	#	***	0.97
	MFG + SVC		#	#				***			-***	-***	***	0.97
POOR	+		#	#	-*			**			***	#	#	0.29
	MFG		#	#	-*			***	*		-***	***	#	0.81
	SVC		#	#				***	**		-***	#	***	0.97
	MFG + SVC		#	#				***	*		-***	-***	***	0.97
PAVED	+		#	#	-*			**			**	#	#	0.29
	MFG		#	#	-*			***	*		-***	***	#	0.81
	SVC		#	#				***	**		-***	#	***	0.97
	MFG + SVC		#	#				***	*		-***	-***	***	0.97
1980 MILES	+	#	337 ***	#				***	***	**	-***	#	#	0.83
	MFG	#	195 ***	#				***	***		-***	***	#	0.87
	SVC	#		#				***	**		-***	#	***	0.97
	MFG + SVC	#		#				***	**		-***	-***	***	0.97
1980 >2LN MILES	+	#	2,757 ***	#	-***		*	**			-*	#	#	0.75
	MFG	#	1,396 ***	#	-***		*	***	**		-***	***	#	0.87
	SVC	#		#				***	**		-***	#	***	0.97
	MFG + SVC	#		#				***	*		-***	-***	***	0.97
HIGHWAY FACILITY RATING	+	#	104 ***	#	-**			***	***	**		#	#	0.85
	MFG	#	65 ***	#	-**			***	***		-***	***	#	0.89
	SVC	#		#				***	**		-***	#	***	0.97
	MFG + SVC	#		#				***	**		-***	-***	***	0.97
EXPENDITURE	+	#	#	1.06 ***	-*			**				#	#	0.38
	MFG	#	#		-**			***	*		-***	***	#	0.81
	SVC	#	#	-0.27 ***				***	**		-***	#	***	0.97
	MFG + SVC	#	#	-0.30 ***				***			-***	-***	***	0.98
PSR + 80MIL + EXP	+		356 ***					***	***	**	-**	#	#	0.83
	MFG		213 ***					***	***		-***	***	#	0.88
	SVC		42 **	-0.31 ***				***	**		-***	#	***	0.97
	MFG + SVC		48 ***	-0.35 ***				***	*		-***	-***	***	0.98

Table 4.12, continued

DEPENDENT VARIABLE : SERVICE WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
PSR + >2LN	+		2,867 +++		-+++		+	+				$	$	0.75
+ EXP	MFG		1,531 +++		-+++		+	+++	++		-+++	+++	$	0.88
	SVC		323 ++	-0.32 +++	-+			+++	++		-+++	$	+++	0.98
	MFG + SVC		232 ++	-0.33 +++				+++			-+++	-+++	+++	0.98
PSR + HFR	+		112 +++	-0.39 ++	-+			+++	+++	++	-+++	$	$	0.85
+ EXP	MFG		73 +++	-0.31 ++	-++			+++	+++	+	-+++	+++	$	0.89
	SVC		16 +++	-0.33 +++				+++	+++		-+++	$	+++	0.98
	MFG + SVC		17 +++	-0.36 +++				+++	++		-+++	-+++	+++	0.98
POOR + 80MI	+	-2.8 ++	361 +++	-0.30 +				+++	+++	+++	-++	$	$	0.84
+ EXP	MFG		223 +++					+++	+++	++	-+++	+++	$	0.88
	SVC	-0.87 +	47 +++	-0.32 +++				+++	+++		-+++	$	+++	0.98
	MFG + SVC	-0.96 ++	54 +++	-0.35 +++				+++	++		-+++	-+++	+++	0.98
POOR + >2LN	+		2,888 +++		-+++		+	+				$	$	0.75
+ EXP	MFG		1,551 +++		-+++		+	+++	++		-+++	+++	$	0.88
	SVC		337 +++	-0.32 +++	-++			+++	++		-+++	$	+++	0.98
	MFG + SVC		246 ++	-0.33 +++				+++	+		-+++	-+++	+++	0.98
POOR + HFR	+	-2.84 ++	114 +++	-0.40 ++	-++			+++	+++	+++	-+++	$	$	0.86
+ EXP	MFG	-2.02 +	76 +++	-0.32 ++	-++			+++	+++	++	-+++	+++	$	0.89
	SVC	-0.94 +	18 +++	-0.33 +++				+++	+++		-+++	$	+++	0.98
	MFG + SVC	-0.99 ++	19 +++	-0.36 +++				+++	++		-+++	-+++	+++	0.98
PAVED+80MIL	+		357 +++					+++	++	++	-++	$	$	0.83
+ EXP	MFG		214 +++					+++	+++		-+++	+++	$	0.88
	SVC		41 ++	-0.31 +++				+++	+++		-+++	$	+++	0.97
	MFG + SVC		46 +++	-0.35 +++				+++	++		-+++	-+++	+++	0.98
PAVED+>2LN	+		2,864 +++		-+++		+	+				$	$	0.75
+ EXP	MFG		1,526 +++		-+++			+++	++		-+++	+++	$	0.88
	SVC		313 ++	-0.32 +++	-++			+++	++		-+++	$	+++	0.97
	MFG + SVC		218 +	-0.33 +++				+++	+		-+++	-+++	+++	0.98
PAVED + HFR	+		112 +++	-0.38 ++	-+			+++	+++	++	-+++	$	$	0.85
+ EXP	MFG		73 +++	-0.30 ++	-++			+++	+++		-+++	+++	$	0.89
	SVC		15 +++	-0.33 +++				+++	+++		-+++	$	+++	0.98
	MFG + SVC		16 +++	-0.36 +++				+++	++		-+++	-+++	+++	0.98

NOTES :

$ = VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT VARIABLES ARE SHOWN

+++ = PARAMETER WAS DIFFERENT FROM 0 AT 1% LEVEL OF SIGNIFICANCE OR LESS

++ = PARAMETER WAS DIFFERENT FROM 0 AT 5% LEVEL OF SIGNIFICANCE OR LESS

+ = PARAMETER WAS DIFFERENT FROM 0 AT 10% LEVEL OF SIGNIFICANCE OR LESS

Possible reasons for this was discussed under the total employment and wage-income models.

- Highway expenditures were significant in many cases and negatively associated, except in the case where is was the only highway variable and no agglomeration variables were used. Coefficient values also stayed relatively constant within each model. This is consistent with previous behavior.
- Other significant variables were the percentage college graduates and the property tax rate, which had respectively a positive and a negative relationship in virtually all cases, as postulated. Electricity rates were significant in some cases, with a negative association as theorized. The distance from the closest Metropolitan Statistical Area were positive significant in many of the regressions, while it had been postulated that this relationship would be negative, i.e. the greater the distance from a MSA, the less the expected economic development would be. This unanticipated relationship could be due to growth in the service sector in counties outside MSAs, because of diversification of markets in this sector. Wages, which were included as a variable in the employment model, was significant with negative association in many instances, as expected.
- The agglomeration variables were significant in all regressions, and had the same relationships with the response variable in the two types of models that were used. Manufacturing and service employment parameters in 1980 were positive and significant when employed separately as

agglomeration variable, but the association of manufacturing employment turned negative when used together with service employment in the same model. This occurrence can probably be attributed to the fact that manufacturing declined over the time period while service industries expanded. The inclusion of agglomeration variables in general had a very positive effect on the adjusted R^2. This parameter increased by over 100 percent in some cases.

- The adjusted R^2 values in these models were very high, up to 0.99 in the employment model and 0.98 in the wage-income model. The most consistently high coefficients of determination were obtained when all three types of highway variables, and service or manufacturing and service employment in 1980, were included in the model. A model with this high an adjusted R^2 has the theoretical potential of providing relatively good forecasts and estimates.

Summary of the Comprehensive Regression Model Analysis

The following statements can be made in general concerning the comprehensive model :

- Overall, road condition was not a significant variable, except in some instances in the service sector. PSR had a positive relationship, while the percentage of poor roads [POOR] was negative, as hypothesized. The percentage of paved roads was not significant in any instances.

- Highway mileage was positively associated and highly significant and positive in most cases in the total employment and service sectors, but with less significance and varying association in the manufacturing sector. This was probably due to influences outside Indiana affecting manufacturing industries. Coefficient values showed consistent behavior in all three models, namely multi-lane miles having much higher coefficient values than the total road mileage within a fixed configuration of highway variables and agglomeration variables. Also, these coefficient values decreased drastically within a fixed set of highway variables when agglomeration variables were added.
- Highway expenditures were, except for the wage-income manufacturing sector model, significant in many cases in all models. The negative association in most cases could be attributed to unreliable data, the short time period of the study, and possibly increasing highway expenditures in economically declining counties, due to expanding construction and maintenance needs. Coefficient values stayed relatively constant, regardless of highway variable configuration or type of agglomeration variable.
- The percentage of college graduates and property tax rate in a county were highly significant, with respectively positive and negative association in almost all the cases, as postulated. Other variables, such as the electricity rate, distance to nearest MSA and nearest large airport, and wage

rates, were significant in different models, in differing degrees. The associations were, in general, as hypothesized.

- The inclusion of agglomeration variables in the models proved to be beneficial, in that the adjusted coefficients of determination improved considerably in most cases. Within a specific industry type and model type (manufacturing or wage-income) the significance and association of these variables did not vary much. Models with the highest adjusted R^2 in the total industry and service sector seemed to be obtained when either just service employment, or service and manufacturing employment in the base year were used as agglomeration variables. In the manufacturing sector the type of agglomeration variable did not make a big difference in the adjusted R^2.

- The adjusted coefficient of determination for the comprehensive model increased considerably from the limited model. The highest values of this parameter in the total employment sector, manufacturing sector, and service sector were respectively 0.75, 0.51 and 0.99. Also, within each specific sector, the employment model attained a higher R^2 in general than with the same regression in the wage-income model. From the values of the adjusted R^2s and the assessment of the performance of different variables in the various models, the conclusion can be made that the total employment and especially the service sector models explained a large percentage of the variance in economic development across Indiana counties over this time period. The manufacturing

sector models did however not do this very well, probably due to influences outside the state whose effect on different counties are difficult to model.

The Sectoral Model

In the next part of the study, the different industrial sectors in the state of Indiana were examined from 1980 to 1988. These analyses were done by using the results from the limited and the comprehensive models, and investigating trends that were identified for consistency at this more disaggregate level of analysis.

Industries with similar characteristics within the general, manufacturing and service sectors were identified and divided into 43 different groups, according to Standard Industrial Classification (SIC) codes between 1 and 93, as described under the regional analysis. For each of these industry groups, the sectoral employment and wage-income data for 1980 and 1988 were obtained. The independent variables in this model were employed in the same way as in the comprehensive model. The dependent variables however varied according to sector. The sectoral model were defined as follows :

$$Y_k = X'B_k + e$$

where

Y_k = dependent or response variable, measured as the change in employment or wage-income in sector k from 1980 to 1988 in a county;

B_k = a vector of regression parameters in sector k, associated with the independent variables;

e = a vector of errors;

X = the vector of independent variables, consisting of the same variables as specified in the comprehensive model, except for the following:

$WAGE_k$ = the wage rate in sector k in a county in 1980.

In all the models, the highway variables of 1980 total road density (ROAD80) and the 1980 total multi-lane density per county (G2LN80) were used, as these variables were identified earlier as being the most appropriate for measuring highway availability. In the case of service employment as dependent variable, the percentage of roads in poor condition (POOR) was also included, because of significance it showed in earlier models. In all cases the agglomeration variables were excluded in initial regressions, and then included in the configuration that gave the highest adjusted R^2 in the state-wide models.

The results from these regressions are presented in the Appendix, and variables that were significant in the various sets of regressions are given, as well as the coefficient

values for highway variables where these were significant. In an effort to identify the trends displayed in each of the 43 SIC groups, summary tables were compiled for the general sector (SIC groups 1 to 4), the manufacturing industry sector (SIC groups 5 to 20), and the service industry sector (SIC groups 21 to 43). These tables were aimed at identifying aggregate trends, rather than investigating individual regressions and attempting to explain why specific variables within a regression were significant or not. These tables will be discussed in detail in the forthcoming section, and variables that were significant in fifty percent or more of regression analyses of a specific industry and dependent variable (employment or wage-income change), will be summarized.

General Industry Sector

In this sector, denoted by SIC groups 1 through 4, industries were included that are typically not classified under either manufacturing or service industries, such as agriculture and mining. The summary results are presented in Table 4.13.

From the table, it is evident that the 1980 total highway density (ROAD80) and 1980 multi-lane highway density (G2LN80) was significant in almost all cases. The association of the ROAD80 parameter was mostly positive, while the G2LN80

Table 4.13 Results from Sectoral Model Regressions in General Industry Sector

GENERAL INDUSTRY SECTOR

SIC GRP	DESCRIPTION	DEP VAR	HIGHWAY VARIABLES	OTHER VARIABLES	AGGL VARIABLES	ADJ. R**2 LOW	HIGH
1	AGRIC, FORESTRY & FISHING	EMPL	ROAD80+,62LN80+-	COLL+,WAG+	SVC+	0.47	0.65
		WG-IN	ROAD80+,62LN80+-	COLL+,TAX-	SVC+	0.46	0.69
2	MINING	EMPL		TAX+,WAG-		0.08	0.10
		WG-IN	62LN80-	TAX+		-0.02	0.02
3	CONTRACTING	EMPL	ROAD80+,62LN80+-	APT-,COLL+,MSA+,TAX-,WAG-	SVC+	0.75	0.92
		WG-IN	ROAD80+,62LN80+-	WATER-,APT-,COLL+ ELEC-,MSA+,TAX-	SVC+	0.65	0.84
4	HEAVY CONSTRUCTION	EMPL	ROAD80-, 62LN80-	ELEC-,APT-,WAG-	MFG-	0.30	0.34
		WG-IN	ROAD80-, 62LN80-	ELEC-,APT-,TAX-	MFG-,SVC+	0.32	0.46

NOTES :

* HIGHWAY VARIABLES column indicates which highway variables were highly to marginally significant (P-value <= 0.1) in at least 50% of regressions.
* OTHER VARIABLES column indicates variables, excluding highway and agglomeration variables, that were significant in at least 50% of regressions.
* AGGL VARIABLES column indicates which agglomeration variables were significant in at least 50% of regressions it was included in.
* ADJUSTED R**2 column indicates the highest and lowest coefficient of determination for each set of regressions.
* ROAD80 indicates the total highway mileage per county in 1980.
  62LN80 indicates the multi-lane mileage per county in 1980.
* A parameter's association, where significant, is indicated by + or -.
* indicates that a variable was not includedin a specific regression.

parameter varied in some cases within the same SIC group and dependent variable, depending on the agglomeration variable.

Other variables that were significant varied from sector to sector. The percentage college graduates was significant with positive association in several cases, and the wage rate had a significant and negative relationship in all but SIC group 1 (agriculture, forestry and fishing), where it was positive. The property tax rate was mostly significant and negative but positive in SIC group 2 (mining).

The adjusted R^2 varied also from sector to sector. The low adjusted R^2 in the mining sector indicates that the model did not explain well the behavior in the response variables in this sector. In other sectors, this parameter had high values varying from 0.46 in the heavy construction sector, to 0.92 in the contracting sector.

Overall, it appears that in the general industrial sector the models were explaining a large amount of the variance in economic development parameters, but specific significant variables had unexpected and conflicting associations with the response variable. The reason for this behavior can possibly be found in the fact that these analyses were done at a fairly disaggregate level, namely for specific industrial sectors. In an industry such as mining, which depends on mineral deposits in a specific geographic location, or agriculture that relies

on available farm land to expand, highway availability and other variables are not necessarily important determinants of economic growth. Unexpected significance and associations of specific variables do not necessarily imply causality. A more detailed analysis of specific industries would probably better explain specific trends in the general industry sector over this time period.

Manufacturing Industry Sector

In Table 4.14, the results from the analyses for SIC code groups 5 through 20 are presented. These are all industries within the manufacturing sector.

As far as highway variables are concerned, the ROAD80 parameter was significant with both dependent variables in only 4 of the 16 groups, and the G2LN80 parameter in only 2 cases. The association varied as well - ROAD80 had mostly a negative association, while G2LN80 was negative in all cases.

Other variables that were significant varied widely in significance and association. The property tax rate was significant with both response variables in 10 of the sectors, and with negative association as postulated in all of these cases, except in SIC group 18 (electric and electronic components). The percentage of college graduates was significant and positive only in SIC groups 13 and 18.

Table 4.14 Results from Sectoral Model Regressions in Manufacturing Industry Sector

SIC GRP	DESCRIPTION	DEP VAR	HIGHWAY VARIABLES	OTHER VARIABLES	AGGL VARIABLES	ADJ. R**2 LOW	ADJ. R**2 HIGH
5	FOOD	EMPL	ROAD80+		MFG+,SVC-	0.55	0.57
	PRODUCTS	WG-IN	ROAD80+		SVC-	0.59	0.61
6	TEXTILES &	EMPL		TAX-		0.07	0.08
	CLOTHING	WG-IN		TAX-	SVC-	0.08	0.10
7	LUMBER, WOOD	EMPL		TAX-	MFG+,SVC-	0.18	0.20
	PRODUCTS	WG-IN		TAX-	MFG+,SVC-	0.18	0.19
8	FURNITURE	EMPL		TAX-	MFG+,SVC-	0.18	0.19
		WG-IN		TAX-	MFG+,SVC-	0.16	0.17
9	PAPER	EMPL		COLL+, WAG-, MSA+		0.02	0.02
	PRODUCTS	WG-IN				-0.04	-0.04
10	PRINTING &	EMPL	ROAD80-	WAG+	MFG-,SVC+	0.49	0.51
	PUBLISHING	WG-IN		TAX-	MFG-,SVC+	0.68	0.68
11	CHEMICAL	EMPL		APT-,WATER+,TAX-,WAG+	MFG-,SVC+	0.40	0.40
	PRODUCTS	WG-IN	ROAD80+	WATER+,TAX-	MFG-,SVC+	0.56	0.58
12	PETRO,COAL,	EMPL	G2LN80-	APT-,TAX-	MFG+,SVC-	0.18	0.22
	PLSTC,RUBR	WG-IN	G2LN80-	APT-,MSA-,TAX-		0.17	0.21
13	LEATHER	EMPL		COLL+		0.03	0.05
	PRODUCTS	WG-IN	G2LN80-	APT-,COLL+		0.07	0.13
14	STONE,CLAY,	EMPL				-0.06	-0.04
	GLASS PRODUCTS	WG-IN				-0.07	-0.08
15	PRIMARY	EMPL	ROAD80+, G2LN80-	TAX-, WAG+	MFG-,SVC+	0.63	0.63
	METAL	WG-IN	ROAD80+	ELEC+-, TAX-	MFG-,SVC+	0.61	0.62
16	FABRICATED	EMPL	G2LN80-	APT-, TAX-		0.24	0.27
	METAL	WG-IN	ROAD80+	TAX-	MFG-,SVC	0.21	0.22
17	INDUSTRIAL	EMPL		WATER-, TAX-		0.11	0.11
	MACHINERY	WG-IN		WATER-,APT+,TAX-		0.15	0.15
18	ELECTR,ELECTRNC	EMPL	ROAD80-	ELEC+, APT-,COLL+, TAX+, WAG-	MFG+,SVC-	0.85	0.86
	EQUIPMENT	WG-IN	ROAD80-	COLL+,MSA-,TAX+	MFG+,SVC-	0.89	0.89
19	TRANSPORTATION	EMPL		TAX-	MFG+,SVC-	0.38	0.39
	EQUIPMENT	WG-IN		COLL+, TAX-	MFG+,SVC-	0.43	0.44
20	INSTRUMENTS,	EMPL	ROAD80-, G2LN80-	MSA-	SVC+	0.14	0.15
	MISC. MANUF.	WG-IN	ROAD80-, G2LN80-		SVC+	0.24	0.24

Agglomeration variables differed in significance and association, depending on the specific sector. In cases where the effect of a large base-year manufacturing employment was negative, it could be argued that industries in a specific sector within a county was discouraged from locating there due to competition and saturated markets. In cases where it was positive, it can be concluded that there were resources already existing in a county, and therefore other industries were encouraged to locate there. In this case it is also possible that the market area was outside the county, and therefore included industries that did not threaten each other's local market area.

The adjusted R^2s that were obtained in the manufacturing sector varied widely. In sector 18 (electric and electronic equipment manufacturing) a high value of 0.89 was obtained, while in 4 of the remaining 15 sectors this value was between 0.50 and 0.90. The rest of the sectors had adjusted R^2s lower than 0.50, with SIC groups 6,7,8,9,13,17 and 20 lower than 0.20.

In summary, this disaggregate approach in the manufacturing sector produced results that were interesting when compared to those obtained from the previous more aggregate models. Previously, highways had a negative association with economic development, both for 1980 total highway mileage and total multi-lane mileage. In the sectoral model, highway density was

significant and positive in some cases. The adjusted R^2 also indicated that in different sectors, the model produced different results. While this parameter previously had a high value of 0.50, in the sectoral model a third of the regressions had a higher value than that. Again, specific trends within a sector could probably be best explained by investigating the individual sector over the time period. Also, it is known that the manufacturing sector had been influenced by factors outside the Indiana and US economy over the time period of analysis.

Service Industry Sector

Table 4.15 presents the results from the sectoral model when applied to industries in the service sector. These analyses included industries in SIC groups 21 through 43.

The road condition as measured by the percentage of roads in poor condition (POOR) was not significant in any of the sectors. The 1980 total highway mileage was significant with positive association in 18 of the 23 SIC groups, while it was negatively associated in only SIC groups 27 and 43, which were general merchandise and miscellaneous services respectively. The 1980 multi-lane mileage was significant with both response variables in 18 of the 23 SIC groups, with a positive association in 14 cases.

Table 4.15 Results from Sectoral Model Regressions in Service Industry Sector

SIC GRP	DESCRIPTION	DEP VAR	HIGHWAY VARIABLES	OTHER VARIABLES	AGGL VARIABLES	ADJ. R**2 LOW	HIGH
21	TRUCKNG, WAREHS, TRANSPORTATION	EMPL	ROAD80+,62LN80-	MSA+	MFG+,SVC+	0.71	0.93
		WG-IN	ROAD80+	MSA+	MFG+,SVC+	0.62	0.83
22	COMMUNICATIONS	EMPL	ROAD80-, 62LN80-	APT-,COLL+		0.31	0.40
		WG-IN	62LN80-	APT-,COLL+,MSA+		0.18	0.22
23	ELECTRC,GAS, SANITARY SVC	EMPL	62LN80+	WATER+,COLL-,TAX-,WAG+		0.10	0.11
		WG-IN	62LN80+	ELEC-,APT+,TAX-	SVC+	0.37	0.46
24	WHOLESALE DURABLE	EMPL	ROAD80+	APT-,COLL+,MSA+,TAX+-	MFG+-	0.55	0.75
		WG-IN	ROAD80+	COLL+,MSA+,TAX-	MFG+,SVC+	0.57	0.73
25	WHOLESALE NON-DURABLE	EMPL	ROAD80+,62LN80-	WATER-,TAX-	SVC+	0.29	0.46
		WG-IN	ROAD80+	ELEC-,WATER-,COLL+,TAX-	MFG+,SVC-	0.38	0.56
26	BLDNG MTRLS, GARDEN SUPPLS	EMPL	ROAD80+	COLL+,TAX-	SVC+	0.67	0.90
		WG-IN	ROAD80+	MSA+,TAX-	MFG-,SVC+	0.56	0.81
27	GENERAL MERCHANDISE	EMPL	ROAD80-, 62LN80-	APT-,COLL+,TAX-,WAG+	MFG-	0.38	0.49
		WG-IN	ROAD80-, 62LN80-	APT-,COLL+,TAX-	MFG-	0.59	0.72
28	FOOD STORES	EMPL	ROAD80+,62LN80+	COLL+, TAX-	SVC+	0.52	0.64
		WG-IN	ROAD80-,62LN80-	ELEC-,APT-,COLL+,TAX-	MFG-	0.59	0.73
29	AUTO DLRS, REPAIR,PARKNG	EMPL	ROAD80+,62LN80+	APT-,COLL+,TAX-	MFG+,SVC+	0.74	0.94
		WG-IN	ROAD80+,62LN80+	APT-,COLL+,TAX-	SVC+	0.67	0.88
30	APPAREL STORES	EMPL	ROAD80+,62LN80+		MFG-,SVC+	0.45	0.57
		WG-IN	ROAD80+,62LN80+	TAX-	MFG-,SVC+	0.38	0.33
31	EATING & DRINKING	EMPL	ROAD80+,62LN80+	COLL+, TAX-	SVC+	0.75	0.95
		WG-IN	ROAD80+,62LN80+	ELEC-,COLL+,TAX-	MFG-,SVC+	0.69	0.93
32	FURNITURE, MISC RETAIL	EMPL	ROAD80+,62LN80+	APT-,COLL+,TAX-	MFG-,SVC+	0.66	0.89
		WG-IN	ROAD80+,62LN80+	COLL+,MSA+,TAX-	MFG-,SVC+	0.66	0.91

Table 4.15, continued

SIC GRP	DESCRIPTION	DEP VAR	HIGHWAY VARIABLES	OTHER VARIABLES	AGGL VARIABLES	ADJ. R**2 LOW	HIGH
33	FINANCE, INSRCE,	EMPL	ROAD80+,62LN80+	ELEC-,COLL+,MSA+,TAX-	MFG-,SVC+	0.64	0.89
	REAL ESTATE	WG-IN	ROAD80+,62LN80+	ELEC-,COLL+,MSA+,TAX-	MFG+,SVC+	0.67	0.93
34	HOTELS &	EMPL	ROAD80+,62LN80+	ELEC-,APT+,MSA+,TAX-	MFG-,SVC+	0.65	0.87
	LODGING	WG-IN	ROAD80+,62LN80+	ELEC-,APT+,MSA+,TAX-	MFG-,SVC+	0.64	0.85
35	PERSONAL	EMPL	ROAD80+,62LN80+	APT-,COLL+,MSA-	MFG+	0.61	0.65
	SERVICES	WG-IN	ROAD80+	APT-,COLL+	MFG+	0.36	0.42
36	BUSINESS	EMPL	ROAD80+,62LN80+	TAX-	SVC+	0.72	0.98
	SERVICES	WG-IN	ROAD80+,62LN80+	MSA+,TAX-	SVC+	0.73	0.96
37	MISC. REPR	EMPL	ROAD80+,62LN80+	COLL-	SVC+	0.71	0.87
	SERVICES	WG-IN	ROAD80+,62LN80+	COLL-,RECR+	SVC+	0.77	0.94
38	MOTION PICTRS,	EMPL	ROAD80+,62LN80+	TAX-,WAG+	MFG-,SVC+	0.75	0.94
	AMUSEMENTS	WG-IN	ROAD80+,62LN80+	MSA+, TAX-	MFG-,SVC+	0.69	0.91
39	HEALTH	EMPL	ROAD80+,62LN80+	COLL+	SVC+	0.77	0.97
	SERVICES	WG-IN	ROAD80+,62LN80+	MSA+, TAX-	MFG-,SVC+	0.76	0.99
40	LEGAL	EMPL	ROAD80+,62LN80+	TAX-	MFG-,SVC+	0.71	0.95
	SERVICES	WG-IN	ROAD80+,62LN80+	APT+,MSA+,TAX-	MFG-,SVC+	0.71	0.94
41	EDUC,LOCAL,	EMPL	ROAD80+,62LN80+	WATER+,COLL+,TAX-,WAG+	SVC+	0.50	0.52
	STATE GOVMT	WG-IN	ROAD80+,62LN80+	WATER+,COLL+,TAX-	MFG-,SVC+	0.78	0.91
42	SOCIAL	EMPL	ROAD80+,62LN80+	COLL+	MFG-,SVC+	0.69	0.82
	SERVICES	WG-IN	ROAD80+,62LN80+	APT-,COLL+, TAX-	MFG-,SVC+	0.71	0.87
43	MISC	EMPL	ROAD80-,62LN80-	COLL+,MSA-	MFG+,SVC-	0.81	0.96
	SERVICES	WG-IN	ROAD80-,62LN80-	APT+,MSA-	MFG+,SVC-	0.72	0.96

NOTES :

* HIGHWAY VARIABLES column indicates which highway variables were highly to marginally significant (P-value <= 0.1) in at least 50% of regressions.
* OTHER VARIABLES column indicates variables, excluding highway and agglomeration variables, that were significant in at least 50% of regressions.
* AGGL VARIABLES column indicates which agglomeration variables were significant in at least 50% of regressions it was included in.
* ADJUSTED R**2 column indicates the highest and lowest coefficient of determination for each set of regressions.
* ROAD80 indicates the total highway mileage per county in 1980. 62LN80 indicates the multi-lane mileage per county in 1980.
* A parameter's association, where significant, is indicated by + or -. # indicates that a variable was not includedin a specific regression.

Other significant variables varied between industrial sectors. The property tax rate was significant with negative association in almost all sectors. The percentage of college graduates was significant in 12 of the 23 SIC groups, with a positive association in 11 of these. The distance to the nearest large airport, and the distance to the nearest Metropolitan Statistical Area were also significant in several cases. The latter parameter mostly had a positive association, indicating that these industries expanded in rural areas of the state.

The adjusted R^2 varied also according to SIC group. In 15 of the 23 sectors, a value of at least 0.80 was obtained with at least one of the two response variables, indicating that the model explained a large percentage of the variance in the response variable. Only in SIC groups 22 (communications) and 23 (electric, gas and sanitary service) was the highest adjusted R^2 value for both response variables lower than 0.50.

In general, the disaggregate service sector model seemed to follow the tendencies identified in previous models. Highway mileage, measured by two variables, was mostly positive and significant. The high adjusted R^2s obtained in the limited and comprehensive models were also found in this model in almost two-thirds of the industry's SIC groups.

In summary, the sectoral comprehensive model had varying results between and within different industry sectors and SIC groups. This could be expected due to the disaggregate nature of the model, which would make it more subject to variances within a specific industry group. In the general industry group, some conflicting results were obtained relative to highway mileage variables, although the overall models seemed to be fairly "good" in terms of the coefficient of determination. In the manufacturing sector, results varied according to sector, but better models were obtained for specific industries, than when the aggregate manufacturing sector model was used. Some unexpected results pertaining to highway variables were also obtained, with total highway density being significant and positively related to economic development in some manufacturing sector groups, contrary to results from the aggregate model. In the service industry sector, highway density was significant in a majority of sectors, with positive association in the majority of cases, which was consistent with the aggregate model. Also, the adjusted R^2s were high in most sectors.

This disaggregate model shed some light on how specific industries, within bigger industrial groupings, responded to the variables which had been hypothesized to determine economic development.

Urban-Rural and Regional Models

In all the regression models that had been defined up to this stage, namely the limited model, the comprehensive models, and the sectoral comprehensive models, individual counties had been treated as an observation in a cross-sectional model. There had been no distinction between urban and rural counties, or between various regions of the state of Indiana.

In the next part of the study, the counties in Indiana were classified according to various population, geographic or locational characteristics within the context of the state. The model that was used was similar to the comprehensive state-wide model, namely :

$$Y = X'B + e$$

where

Y = dependent or response variable, measured as the change in total, manufacturing or service employment or wage-income from 1980 to 1988 in a county;

B = a vector of regression parameters, associated with the independent variables;

e = a vector of errors;

X = a vector of independent variables.

For analysis purposes, a set of models in which the highway variables had been significant in the comprehensive state-wide model, were identified and selected for sensitivity testing. This included all three industry sectors and both employment and wage-income as dependent variables. No models from the limited model analysis were selected, due to the low explanatory power associated with most of these.

Separate regressions were performed within a specific model for each group of counties, to examine the nature of the relationship between highways and economic development for the varying types of counties. In all four of the classifications, 3 county groupings were developed. Although all the models identified from the comprehensive state-wide model were subjected to analysis, only these in which there was a significant association with the highway variable in all three groups of counties, were presented under the relevant analysis' results.

County Group 1 : Urban and Rural Counties

In this analysis, counties were classified according to their urbanization characteristics. The base group was counties within a Metropolitan Statistical Area in 1980, and numbered 34. The second group was large rural counties, or those counties that were considered as non-metropolitan, with the largest town's population exceeding 10,000 people. Nineteen

counties fell in this category. The third group was small rural counties, or counties of which the biggest town had less than 10,000 people, and comprised the remaining 39 counties in Indiana. The county classification is presented in Figure 4.1.

Parameter values where the highway variable was significant in all three groups are presented in Table 4.16. This occurred only in some models in the service employment sector, and the results indicate that multi-lane highways were significantly and positively associated with economic growth. The highest coefficient values were obtained for urban counties, followed by large and small rural counties. The adjusted R^2 were also the highest in the urban models. In most of the other models included in the analysis, highways were also significant in the urban models, but had varying significance and generally lower adjusted R^2 in models for large and small rural counties. The conclusion can be made that economic growth was concentrated in urban areas, where highways played a significant role. In non-urban areas, the models did not explain the response variable as well as in the urban areas.

Group 2 : Counties With and Without Interstate Highways

In the next analysis, the investigation was aimed at how counties in urban areas developed economically compared to counties outside urban areas, with and without interstate highways. Similar to the Group 1 analysis, the base group was

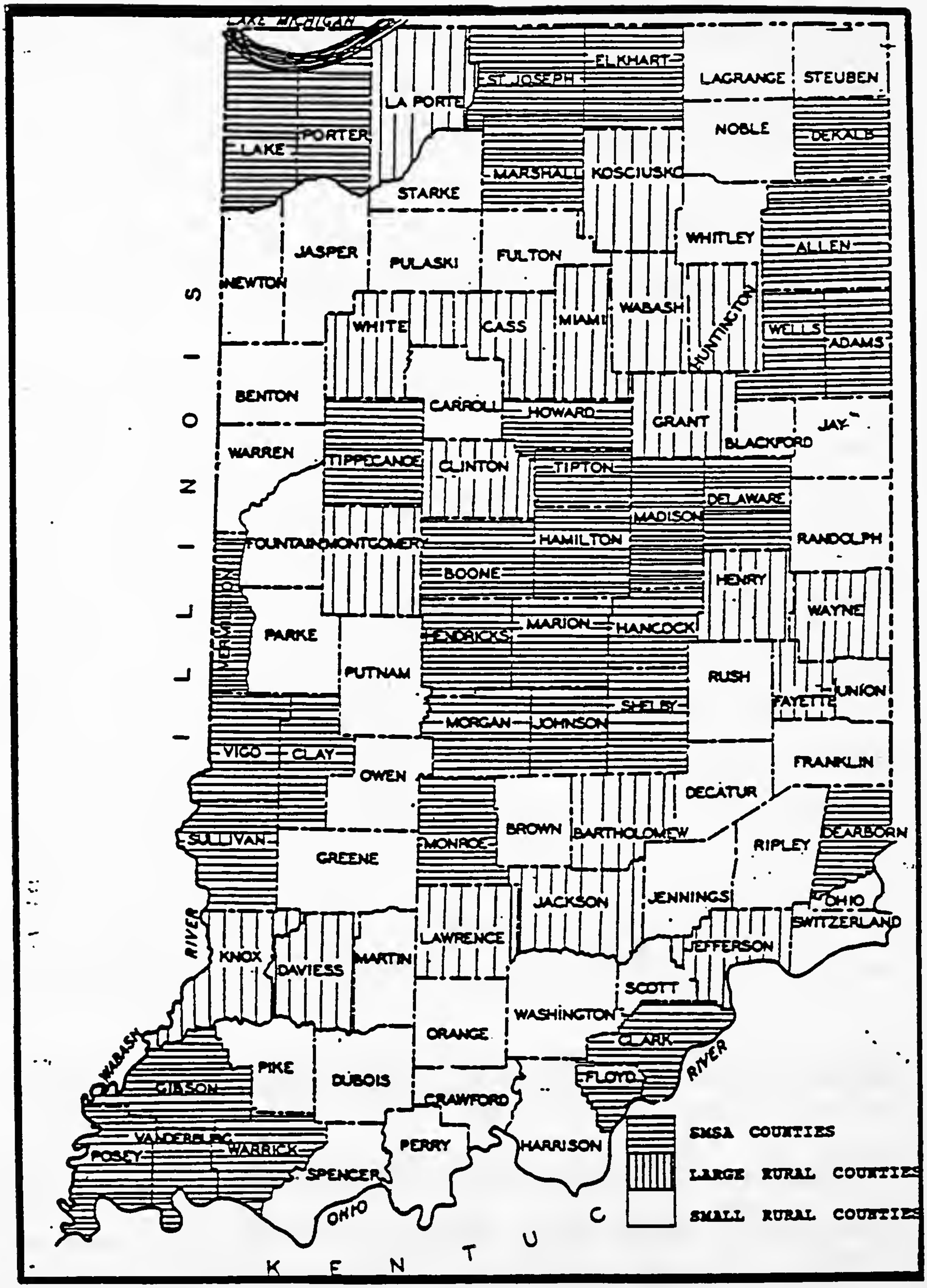


Figure 4.1 Urban-Rural County Classification

Table 4.16 Results from Urban-Rural Model Regressions: County Classification 1

DEPENDENT VARIABLE	ROAD VARIABLE	GROUP 1 VALUE	GROUP 1 SIG	GROUP 1 R**2	GROUP 2 VALUE	GROUP 2 SIG	GROUP 2 R**2	GROUP 3 VALUE	GROUP 3 SIG	GROUP 3 R**2
SVCEMP	1980>2LN MILE	126,504	***	0.87	26,003	**	0.56	7594	*	0.20
SVCWAGINC	1980>2LN MILE	3,078	***	0.85	450	**	0.47	153	**	0.36

GROUP A : COUNTIES IN SMSA (34 COUNTIES)
GROUP B : LARGE RURAL COUNTIES (19 COUNTIES)
GROUP C : SMALL RURAL COUNTIES (39 COUNTIES)

NOTES :
PARAMETER VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN
*** = VARIABLE WAS DIFFERENT FROM 0 AT 1% LEVEL OF SIGNIFICANCE OR LESS
** = VARIABLE WAS DIFFERENT FROM 0 AT 5% LEVEL OF SIGNIFICANCE OR LESS
* = VARIABLE WAS DIFFERENT FROM 0 AT 10% LEVEL OF SIGNIFICANCE OR LESS
SVCEMP = CHANGE IN SERVICE SECTOR EMPLOYMENT BETWEEN 1980 AND 1988
SVCWAGINC = CHANGE IN SERVICE SECTOR WAGE-INCOME BETWEEN 1980 AND 1988

counties within MSA's. The second classification was counties outside MSA's that contained interstates within their borders, and numbered 27 in total. The third group namely counties outside MSA's, without interstates, totaled 31. Figure 4.2 shows the county classifications.

Highways did not have a statistically significant association with economic development in all three county groups in any of the models. The results for the urban models were the same as in the previous section, as MSA counties again constituted this group. In the non-MSA counties with interstate highways, the total highway mileage density and the multi-lane mileage density were not significantly different from zero in many cases except in the service sector, where highway parameter values were in general positive but lower than in the urban models.

Adjusted R^2s were also lower than in the urban models. Non-MSA counties without interstates showed little and varying significant association between economic growth and either total miles or multi-lane miles in all economic sectors, and generally had low adjusted R^2s, indicating that the models did not explain economic growth in rural counties very well.

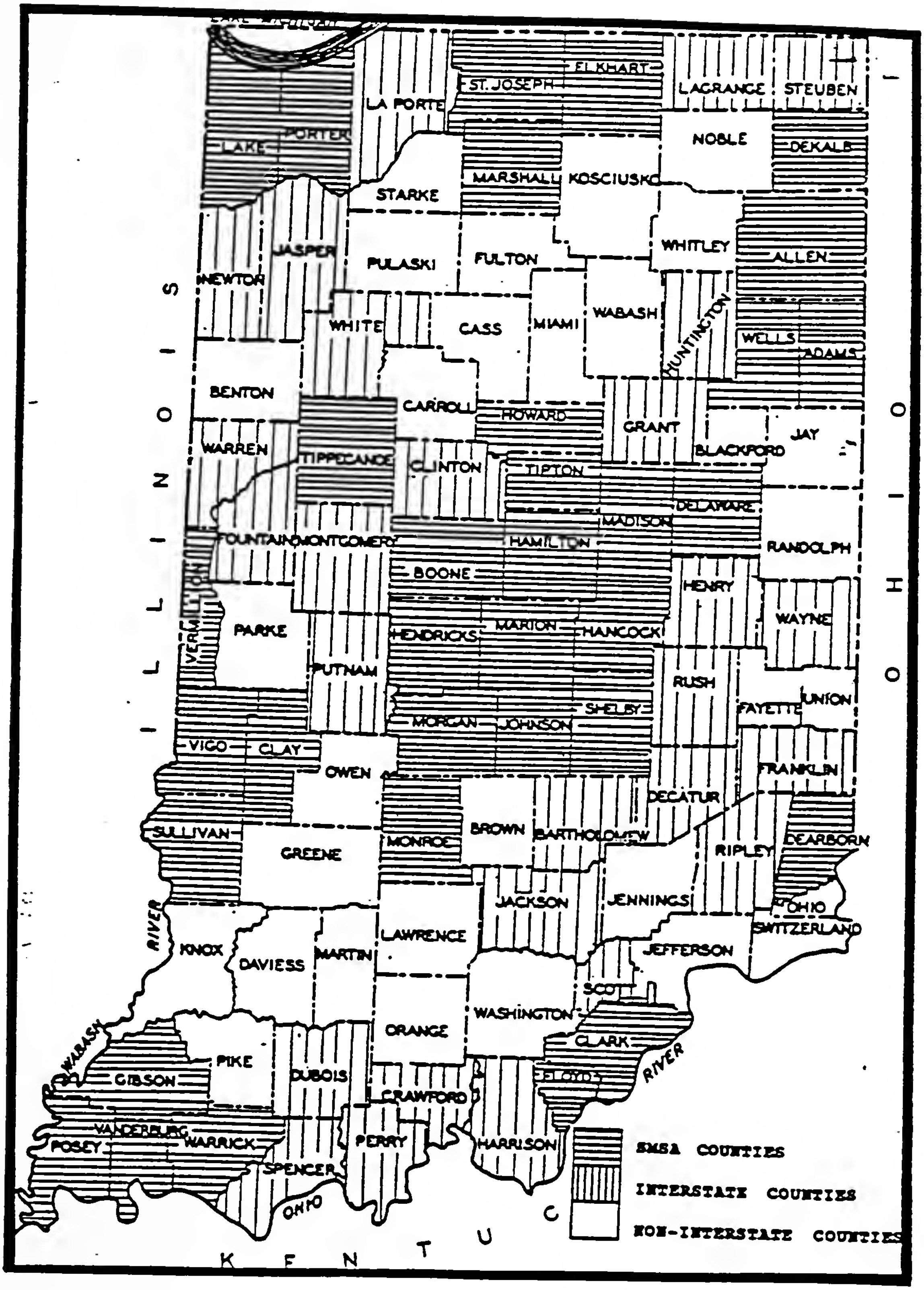


Figure 4.2 Urban and Interstate County Classification

Group 3 : Counties Classified by Percentage Commuters

It was attempted to determine if there was a significant difference in economic development between counties with a significant amount of commuters, and counties with either an urban or a rural character. The base group were counties that had an intrinsic urban character, determined by the presence of a town of 20,000 or more. The second group were counties where more than 30 percent of the employees commuted to work outside the county in 1980 [USDOC 1983], but without any towns with population more than 20,000, thus indicating "exurban counties" [Nelson 1990]. The third group were counties that had no large towns or large commuter groups. The three different county groups are shown in Figure 4.3.

None of the models indicated a significant association between economic growth and highways in all 3 county groups. Similar to previous results, in urban counties there was a positive and significant association between the two parameters, although multi-lane highways displayed varying association and significance. Adjusted R^2s were still high in general. In the exurban county models, highways were positively related in most cases, although in some cases the multi-lane highway parameter displayed the same inconsistent behavior as in urban counties. Rural counties' economic development were significantly associated with highways in very few models, where this relationship was positive.

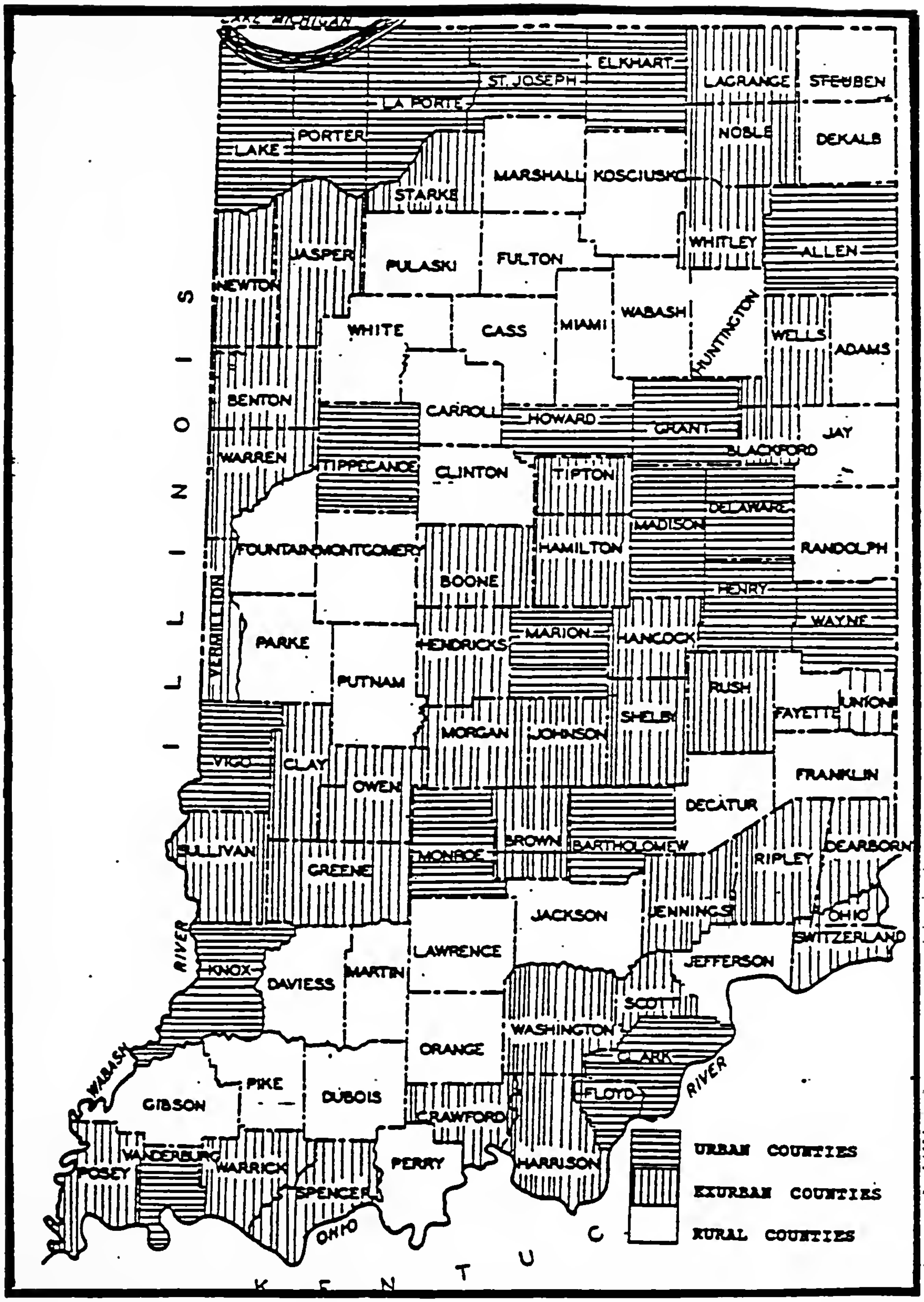


Figure 4.3 Urban-Rural and Commuting County Classification

It should be noted that all the employment and wage-income data were based on county of employment and not of residence, and therefore just indicated changes in these parameters in the actual county where a work place was located. The conclusion can be made that although urban counties displayed the highest economic growth and association with highway parameters, exurban counties contributed to the work force in these areas by providing employers that commute to work. In this regard, highways were important to provide employers with the means of reaching employment opportunities.

Group 4 : Regional Classification of Counties

The final classification was done according to the geographic location of counties : North, Central and South. The Northern section was viewed as the base group, and consisted of 27 counties, while the Central and Southern regions contained respectively 32 and 33 counties, as shown in Figure 4.4. The classification was based on highway districts, with some exceptions, such as Morgan and Johnson Counties which were allocated to the Central Region.

Table 4.17 shows parameter values for models in which highways were significantly associated with economic development in all three regions in the state, namely in some models in the service sector. This association had the highest parameter values in the Central part of the state, followed by the

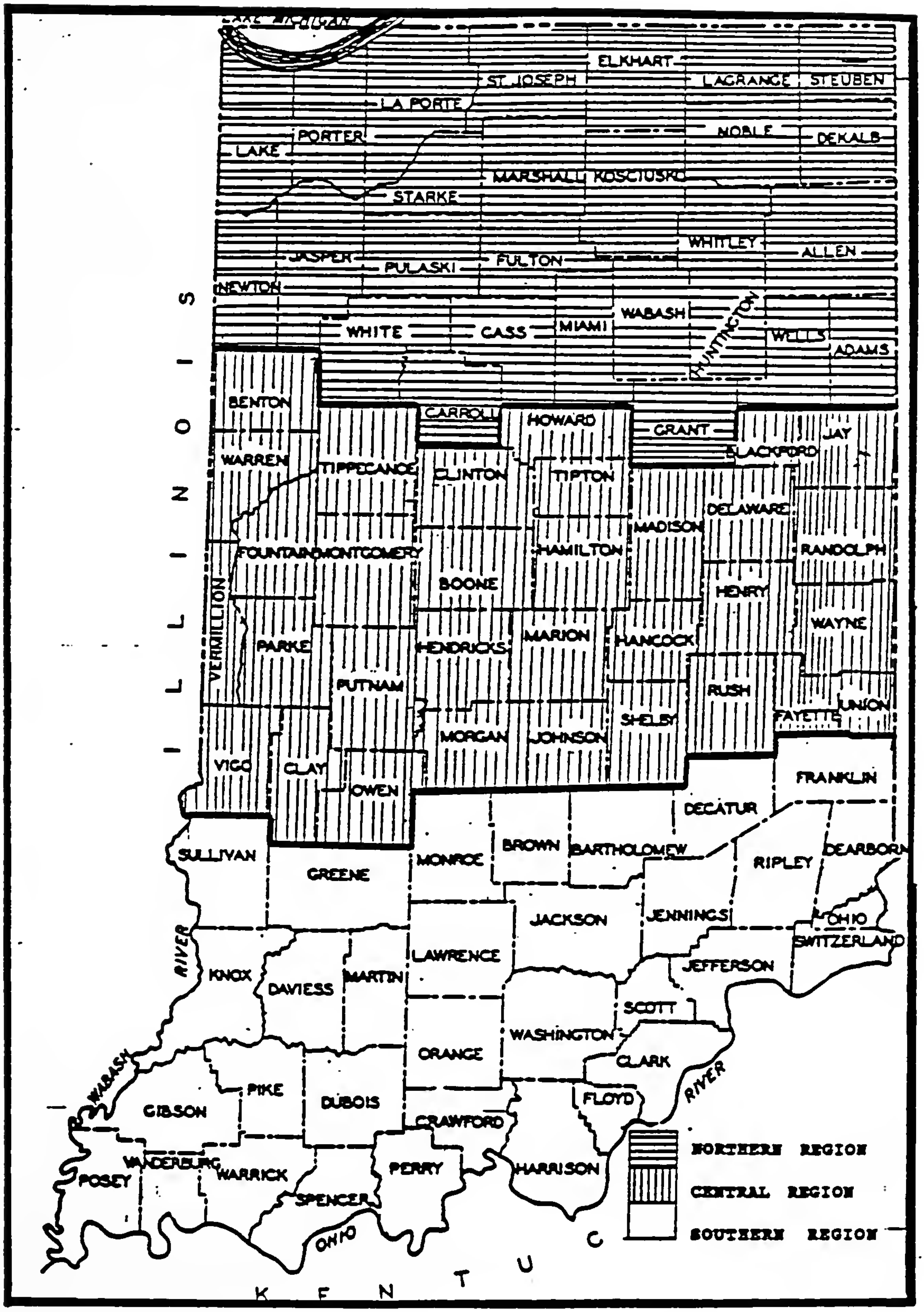


Figure 4.4 Regional County Classification

Table 4.17 Results from Regional Model Regressions: County Classification 4

DEPENDENT VARIABLE	ROAD VARIABLE	GROUP 1 VALUE	SIG	R**2	GROUP 2 VALUE		R**2	GROUP 3 VALUE	SIG	R**2
SVCEMP	1980 MILES	7,674	**	0.84	18,383	***	0.97	2468	**	0.79
SVCWAGINC	1980 MILES	153	*	0.80	437	***	0.97	40	**	0.81

GROUP A : NORTHERN INDIANA (27 COUNTIES)
GROUP B : CENTRAL INDIANA (32 COUNTIES)
GROUP C : SOUTHERN INDIANA (33 COUNTIES)

NOTES :
PARAMETER VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN
*** = VARIABLE WAS DIFFERENT FROM 0 AT 1% LEVEL OF SIGNIFICANCE OR LESS
** = VARIABLE WAS DIFFERENT FROM 0 AT 5% LEVEL OF SIGNIFICANCE OR LESS
* = VARIABLE WAS DIFFERENT FROM 0 AT 10% LEVEL OF SIGNIFICANCE OR LESS
SVCEMP = CHANGE IN SERVICE SECTOR EMPLOYMENT BETWEEN 1980 AND 1988
SVCWAGINC = CHANGE IN SERVICE SECTOR WAGE-INCOME BETWEEN 1980 AND 1988

Northern part and the South. In Central Indiana, the highway variables were significant with positive association in most models, and with relatively the highest adjusted R^2 values compared to the other regions. Northern Indiana counties displayed a significant association between highways and economic growth only in some cases in the service sector, where this relationship was positive. In the Southern counties of the state, this situation was the same.

In summary, the following conclusions can be made from this analysis :

- Highways were significantly associated with economic development in urban areas. In rural areas, this relationship was not as consistent.
- In large rural and exurban counties, highways were related with economic growth, but not to the same extent as in urban areas.
- In the Central part of the state, highways were significantly related to economic development to a large extent. This was not the same for the North or the South, except in the service sector.
- The regional models did not display the same robust and consistent behavior as in previous models, except in urban models, confirming that economic development in rural areas are more difficult to explain than in urban areas.

Forecasting Models

The final analysis in this part of the study was aimed at developing models that could be used for estimating the impact that a highway infrastructure project would have on the economy of the counties where it is undertaken.

Up to this stage, all the models that were developed were aimed at investigating trends, to determine if highways were significantly associated with economic development in Indiana over the time period from 1980 to 1988. Seven highway variables in the broad categories of pavement condition, highway mileage in different classes and highway expenditures, were used to examine this relationship, with economic development measured by a total of six variables in three industry categories. It was found that, in general, highway condition did not have a robust appearance as a significant variable, except under certain circumstances in the service industry sector. Highway expenditures did not prove to be a good measure of highway impacts on economic growth, partly because of data limitations, and partly due to localized spending with marginal economic impact. Highway facility extent, as measured by mileage density in different classes and a capacity rating, was found to be of more or less consistent importance. The two variables of total mileage density in 1980 (ROAD80), and the multi-lane density in 1980 (G2LN80), were used in analyses of individual industries

according to SIC group, and also in county type-specific analyses. Although estimated coefficient values were given in the models, these were only used to identify trends, and not to make specific interpretations of a quantitative nature.

In order to develop forecasting models, further analysis was necessary. The reason for this was that in cross-sectional studies such as this, where county-by-county data were used, heteroscedasticity or non-constant error variance across observations can provide faulty results. Serious heteroscedasticity can increase error variance, and thereby provide parameters that are still linear and unbiased, but that are not the "best". The BLUE or "best among linear unbiased estimators" - characteristic of ordinary least-squares regression analysis (OLS) is violated, because these estimators do not have minimum variance. As a result, heteroscedasticity can cause misleading hypothesis testing, indicating for example that a variable was significant, when in fact it was not [Doran 1989].

In order to test for the aptness of models in general, and the presence of heteroscedasticity specifically, two measures were undertaken. The models that were used in this analysis were the same that had been identified earlier in the study. Combinations of highway variables, where these were consistently significant in the comprehensive state-wide models were also included, with the highest adjusted R^2

combination of agglomeration variables included. Initially, residual analysis was done by plotting residuals versus predicted values of the dependent variable for all the models to investigate suitability of models. In several of these plots, some degree of non-constant error variance was detected, in that residuals appeared to increase with an increase in the predicted variable value. Also, two observations were detected in most plots that did not appear to fit the model reasonably, and could therefore possibly be classified as outliers. These observations were identified as Marion and Lake Counties, which showed large changes in both employment and wage-income in many sectors throughout the time period.

The second measure, aimed specifically at detecting heteroscedasticity, was Glejser's test [Wetherill 1986]. The absolute values of residuals were regressed against variables that were suspected of being associated with heteroscedasticity. In this case, such variables would be those where the variance in large counties would not be the same as in smaller counties. Firstly, the dependent variable namely total, manufacturing or service sector employment or wage-income change could be expected to have a different variance across counties, depending on the county size. Glejser tests were performed and it was found that there existed a significant relationship between the absolute values

of the residuals and these variables, indicating heteroscedasticity.

Several alternative measures were taken to correct for heteroscedasticity in the models that had been identified :

-Deletion of outliers, namely Lake and Marion Counties, did not appear to remove non-constant error variances. As typically happens, other observations emerged as new possible outliers, and Glejser's test indicated that heteroscedasticity still existed in models without these two observations.

-Normalizing of response variables in two different ways was also investigated. The first measure was to divide the response variable by the county area to adjust for county size. This did not ameliorate the problem, probably because more economic growth is not necessarily implied by a larger county. A better approximation was to divide by the county population, which relates to the available work force in a county, and this can also be an indication of economic activity. In several cases, this measure alleviated the heteroscedasticity problem.

-Weighted Least Squares (WLS) was performed, using the county population in 1980, as well as the square of the county population in 1980 as the weight in separate regressions. This procedure is well-recognized as a way of relieving heteroscedasticity [eg. Neter, Wasserman and Kutner 1985; Aschauer 1990]. By weighing each observation in a model by the same variable, the effect of large observations is decreased,

and that of smaller observations increased. This measure proved to be more effective in alleviating heteroscedasticity, as detected by Glejser's test.

The best three measures of correcting heteroscedasticity, namely normalizing the dependent variable by the county population, and WLS with the two different weights as specified, were applied to all the identified models. Glejser's test was subsequently applied to all transformed models to test if the problem was corrected, and the results for these three transformations, together with results from the original models, are presented in Table 4.18. It is evident from the table that in the total and service industry sectors, several models were identified that had no heteroscedasticity associated with them, according to Glejser's test. In the manufacturing sector, this problem was still present in all models after transformation.

In the final selection of models for prediction purposes and for transformations to be applied, the following criteria were used :

- No heteroscedasticity present with respect to the dependent variable or agglomeration variables, as detected by Glejser's test;
- For the same highway and agglomeration variables, and with no heteroscedasticity present in more than one model type, the highest adjusted R^2 was used as criterium for selection.

Table 4.18 Results from Glejer's Tests for Heteroscedasticity

DEPENDENT VARIABLE : TOTAL EMPLOYMENT CHANGE 1980-88

		ORIGINAL MODEL					DEPENDENT VARIABLE/1980 POPULATION				
ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	R**2	GLEJ	CONDITION	MILES	EXP	R**2	GLEJ
1980 MILES	NONE	‡	9,231 ***	‡	0.66	**	‡		‡	0.23	**
	MFG	‡	5,403 ***	‡	0.69	**	‡		‡	0.25	**
	MFG + SVC	‡		‡	0.72	**	‡		‡	0.31	**
1980 >2LN MILES	NONE	‡	69,162 ***	‡	0.54	**	‡		‡	0.22	**
	MFG	‡	26,519 **	‡	0.67	**	‡		‡	0.26	**
	MFG + SVC	‡		‡	0.72	**	‡		‡	0.30	**

DEPENDENT VARIABLE : TOTAL WAGE-INCOME CHANGE 1980-88

		ORIGINAL MODEL					DEPENDENT VARIABLE/1980 POPULATION				
ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	R**2	GLEJ	CONDITION	MILES	EXP	R**2	GLEJ
1980 MILES	NONE	‡	237 ***	‡	0.60		‡		‡	0.23	**
	MFG + SVC	‡	97 *	‡	0.67	**	‡		‡	0.25	**
1980 >2LN MILES	NONE	‡	1,709 ***	‡	0.47	**	‡		‡	0.21	**
	MFG	‡	988 ***	‡	0.52	**	‡		‡	0.25	**
	MFG + SVC	‡		‡	0.66	**	‡		‡	0.24	**

DEPENDENT VARIABLE : MANUFACTURING EMPLOYMENT CHANGE 1980-88

		ORIGINAL MODEL					DEPENDENT VARIABLE/1980 POPULATION				
ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	R**2	GLEJ	CONDITION	MILES	EXP	R**2	GLEJ
1980 MILES	SVC	‡		‡	0.50	**	‡		‡	0.23	**
	MFG + SVC	‡		‡	0.49	**	‡		‡	0.29	**
1980>2LN MI	SVC	‡		‡	0.51	**	‡		‡	0.24	**
	MFG + SVC	‡		‡	0.50	**	‡		‡	0.29	**

DEPENDENT VARIABLE : MANUFACTURING WAGE-INCOME CHANGE 1980-88

		ORIGINAL MODEL					DEPENDENT VARIABLE/1980 POPULATION				
ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	R**2	GLEJ	CONDITION	MILES	EXP	R**2	GLEJ
1980 MILES	MFG	‡	62 *	‡	0.48	**	‡		‡	0.17	**
	MFG + SVC	‡	72 *	‡	0.47	**	‡		‡	0.21	**
1980>2LN MI	MFG + SVC	‡	(513) *	‡	0.48	**	‡		‡	0.22	**

Table 4.18, continued

DEPENDENT VARIABLE : SERVICE EMPLOYMENT CHANGE 1980-88

		ORIGINAL MODEL					DEPENDENT VARIABLE/1980 POPULATION				
ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	R**2	GLEJ	CONDITION	MILES	EXP	R**2	GLEJ
POOR	MFG + SVC	-34 *	#	#	0.98	**		#	#	0.53	
1980 MILES	*	#	14,489 ***	#	0.84	**	#	566 **	#	0.54	
	MFG	#	7,729 ***	#	0.90	**	#		#	0.54	
	MFG + SVC	#		#	0.98	**	#		#	0.53	
1980 >2LN MILES	*	#	117,598 ***	#	0.77	**	#	5,001 **	#	0.54	
	MFG	#	58,239 ***	#	0.91	**	#		#	0.54	
	MFG + SVC	#		#	0.98	**	#		#	0.54	
PSR+80MI+EI	MFG + SVC	164 *	1,596 ***	-11 ***	0.99	**				0.53	
PSR+62L+EI	MFG + SVC	168 *	10,734 **	-10 ***	0.99	**				0.53	
PR+80MI+EXP	MFG + SVC	-44 **	1,847 ***	-10.8 ***	0.99	**				0.53	
PR+62L+EXP	MFG + SVC	-38 **	11,212 ***	-10.4 ***	0.99	**				0.53	

DEPENDENT VARIABLE : SERVICE WAGE-INCOME CHANGE 1980-88

		ORIGINAL MODEL					DEPENDENT VARIABLE/1980 POPULATION				
ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	R**2	GLEJ	CONDITION	MILES	EXP	R**2	GLEJ
1980 MILES	*	#	337 ***	#	0.83	**	#	15 ***	#	0.65	
	MFG	#	195 ***	#	0.87	**	#	12 *	#	0.64	
	MFG + SVC	#		#	0.97	**	#		#	0.64	*
1980 >2LN MILES	*	#	2,757 ***	#	0.75	**	#	125 ***	#	0.64	
	MFG	#	1,396 ***	#	0.87	**	#	84 *	#	0.64	*
	MFG + SVC	#		#	0.97	**	#		#	0.64	*
PSR+80MI+EI	MFG + SVC		48 ***	-0.35 ***	0.98	**				0.64	*
PR+80MI+EXP	MFG + SVC	-0.9 **	54 ***	-0.35 ***	0.98	**				0.64	*
PR+62LN+EI	MFG + SVC		246 **	-0.33 ***	0.98	**				0.64	*

NOTES :
PARAMETER VALUES FOR SIGNIFICANT VARIABLES ARE SHOWN
= VARIABLE NOT INCLUDED IN REGRESSION
*** = PARAMETER WAS DIFFERENT FROM 0 AT 1% LEVEL OF SIGNIFICANCE OR LESS
** = PARAMETER WAS DIFFERENT FROM 0 AT 5% LEVEL OF SIGNIFICANCE OR LESS
* = PARAMETER WAS DIFFERENT FROM 0 AT 10% LEVEL OF SIGNIFICANCE OR LESS
GLEJ COLUMN : ** = AT LEAST ONE OF VARIABLES HAD P-VALUE OF <= 0.05
(GLEJSER'S TEST) * = AT LEAST ONE OF VARIABLES HAD P-VALUE OF < 0.10
NO ENTRY : ALL P-VALUES > 0.10, NO HETEROSCEDASTICITY

Table 4.18, continued

DEPENDENT VARIABLE : TOTAL EMPLOYMENT CHANGE 1980-88

ROAD VAR	AGGLOM VAR	WLS : WEIGHT=1/(1980 POPULATION) CONDITION	MILES	EXP	R**2	GLEJ	WLS : WEIGHT=1/(1980 POPULATION**2) CONDITION	MILES	EXP	R**2	GLEJ
1980 MILES	NONE		1,220 **		0.18					0.11	
	MFG				0.34	**				0.31	*
	MFG + SVC				0.37	**		(536)**		0.46	*
1980 >2LN MILES	NONE		10,029 **		0.16			7,174 **		0.16	
	MFG		8,990 **		0.38	**		5,721 **		0.34	**
	MFG + SVC		7,946 **		0.40	**		5,500 **		0.47	**

DEPENDENT VARIABLE : TOTAL WAGE-INCOME CHANGE 1980-88

ROAD VAR	AGGLOM VAR	WLS : WEIGHT=1/(1980 POPULATION) CONDITION	MILES	EXP	R**2	GLEJ	WLS : WEIGHT=1/(1980 POPULATION**2) CONDITION	MILES	EXP	R**2	GLEJ
1980 MILES	NONE		26 **		0.17					0.07	
	MFG + SVC				0.34	**		(14)**		0.39	**
1980 >2LN MILES	NONE		164 **		0.14			78 **		0.09	
	MFG				0.34	**				0.31	**
	MFG + SVC				0.34	**				0.34	**

DEPENDENT VARIABLE : MANUFACTURING EMPLOYMENT CHANGE 1980-88

ROAD VAR	AGGLOM VAR	WLS : WEIGHT=1/(1980 POPULATION) CONDITION	MILES	EXP	R**2	GLEJ	WLS : WEIGHT=1/(1980 POPULATION**2) CONDITION	MILES	EXP	R**2	GLEJ
1980 MILES	SVC				0.06	**		(357)**		0.28	**
	MFG + SVC				0.11	**		(374)**		0.27	**
1980>2LN MI	SVC				0.06	**				0.24	**
	MFG + SVC				0.12	**				0.23	**

DEPENDENT VARIABLE : MANUFACTURING WAGE-INCOME CHANGE 1980-88

ROAD VAR	AGGLOM VAR	WLS : WEIGHT=1/(1980 POPULATION) CONDITION	MILES	EXP	R**2	GLEJ	WLS : WEIGHT=1/(1980 POPULATION**2) CONDITION	MILES	EXP	R**2	GLEJ
1980 MILES	MFG				0.14	**		(7) *		0.32	**
	MFG + SVC				0.17	**		(8) *		0.34	**
1980>2LN MI	MFG + SVC				0.17	**				0.31	**

Table 4.18, continued

DEPENDENT VARIABLE : SERVICE EMPLOYMENT CHANGE 1980-88

		WLS : WEIGHT=1/(1980 POPULATION)					WLS : WEIGHT=1/(1980 POPULATION**2)				
ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	R**2	GLEJ	CONDITION	MILES	EXP	R**2	GLEJ
POOR	MFG + SVC		#	#	0.79	**		#	#	0.80	**
1980 MILES	*	#	1,291 ***	#	0.43		#	541 **	#	0.41	
	MFG	#		#	0.60	*	#		#	0.56	**
	MFG + SVC	#		#	0.80	*	#		#	0.80	**
1980 >2LN	*	#	6,739 **	#	0.39		#	3,815 ***	#	0.42	
MILES	MFG	#	4,216 *	#	0.61	*	#		#	0.57	**
	MFG + SVC	#	2,967 *	#	0.80	**	#		#	0.80	**
PSR+80MI+EX	MFG + SVC	-51 *			0.80	**				0.82	**
PSR+62L+EX	MFG + SVC		4,146 *	-8.2 *	0.81	**				0.82	**
PR+80MI+EXP	MFG + SVC				0.79	**				0.79	**
PR+62L+EXP	MFG + SVC		5,399 **	-8.4 *	0.81	**		3,048 **		0.81	**

DEPENDENT VARIABLE : SERVICE WAGE-INCOME CHANGE 1980-88

		WLS : WEIGHT=1/(1980 POPULATION)					WLS : WEIGHT=1/(1980 POPULATION**2)				
ROAD VAR	AGGLOM VAR	CONDITION	MILES	EXP	R**2	GLEJ	CONDITION	MILES	EXP	R**2	GLEJ
1980 MILES	*	#	27 ***	#	0.38		#	9 ***	#	0.35	
	MFG	#		#	0.52	**	#		#	0.49	**
	MFG + SVC	#		#	0.76	**	#		#	0.75	**
1980 >2LN	*	#	174 ***	#	0.35		#	81 ***	#	0.38	
MILES	MFG	#	92 *	#	0.54	**	#	43 **	#	0.52	**
	MFG + SVC	#		#	0.77	**	#		#	0.75	**
PSR+80MI+EI	MFG + SVC				0.77	**				0.80	**
PR+80MI+EXP	MFG + SVC				0.76	**		-4.3 *		0.75	**
PR+62LN+EI	MFG + SVC		72 *	-0.15 *	0.77	**				0.74	**

NOTES :
PARAMETER VALUES FOR SIGNIFICANT VARIABLES ARE SHOWN
= VARIABLE NOT INCLUDED IN REGRESSION
*** = PARAMETER WAS DIFFERENT FROM 0 AT 1% LEVEL OF SIGNIFICANCE OR LESS
** = PARAMETER WAS DIFFERENT FROM 0 AT 5% LEVEL OF SIGNIFICANCE OR LESS
* = PARAMETER WAS DIFFERENT FROM 0 AT 10% LEVEL OF SIGNIFICANCE OR LESS
GLEJ COLUMN : ** = AT LEAST ONE OF VARIABLES HAD P-VALUE OF <= 0.05
(GLEJSER'S TEST) * = AT LEAST ONE OF VARIABLES HAD P-VALUE OF < 0.10
NO ENTRY : ALL P-VALUES > 0.10, NO HETEROSCEDASTICITY

Also, it should be noted that in the models with service employment as response variable and total mileage and multi-lane mileage respectively as highway variable, several models with varying agglomeration variable configuration and no heteroscedasticity had different significance of the highway variable. The adjusted R^2 was the same for most of the models. The significance or not of the highway variable was possibly affected by multicollinearity, or the high correlation between this variable and the agglomeration variables, due to a larger highway density in counties with large base-year employment.

A total of eight models were identified for forecasting purposes. The models include alternatively the total highway mileage (ROAD80) and the multi-lane mileage (G2LN80), with total and service employment and wage-income change individually as response variables. Table 4.19 presents these models with estimated coefficient values and other pertinent statistical parameter values. It is clear from the table that in each sector, the G2LN80 coefficient exceeded the ROAD80 coefficient considerably. Also, the total employment highway coefficient values were higher than the values in corresponding models in the service sector. The parameter values for highway infrastructure indicate that mean county employment had a mean increase of 1,220 jobs associated with a one unit increase in the total highway mileage density per county, and all other variables held constant. This translates

Table 4.19 Forecasting Models

MODEL 1

TEMP = -4,968** + 1,220 ROAD80** - 18,336 ELEC80 + 202 WATER* - 11 APT + 24,763 PCOLL*** + 26 MSA* -0.00206 RECR + 66 TAX+ 0.0136 TOTWAG80

ADJ. R**2=0.18   SSR=0.09478   SSE=0.27401   METHOD : WLS, WEIGHT=LPOP80

MODEL 2

TEMP = 1671 + 7,174 G2LN80** - 71,227 ELEC80*** + 206 WATER*** +6.24 APT + 12,663 PCOLL** + 37 MSA*** -0.00637 RECR - 179 TAX - 0.0602 TOTWAG80

ADJ. R**2=0.16   SSR=9.979E-11   SSE=3.153E-10   METHOD : WLS, WEIGHT=LPOP80**2

MODEL 1

TWAGINC = -103** + 28 ROAD80** - 358 ELEC80 + 3.97 WATER* - 0.2606 APT + 619 PCOLL*** + 0.5918 MSA* - 3.204E-5 RECR + 1.4237 TAX

ADJ. R**2=0.17   SSR=4.025E-5   SSE=1.26E-4   METHOD : WLS, WEIGHT = LPOP80

MODEL [illegible]

TWAGINC = -21 + 164 G2LN80** - 982 ELEC80 + 4.97 WATER** - 0.374 APT + 498 PCOLL*** + 0.709 MSA** -0.00013 RECR + 0.7068 TAX

ADJ. R**2=0.14   SSR=3.67E-5   SSE=1.32E-4   METHOD : WLS, WEIGHT = LPOP80

NOTE : * = VARIABLE DIFFERENT FROM ZERO AT 10% LEVEL OF SIGNIFICANCE
** = VARIABLE DIFFERENT FROM ZERO AT 5% LEVEL OF SIGNIFICANCE
*** = VARIABLE DIFFERENT FROM ZERO AT 1% LEVEL OF SIGNIFICANCE
TEMP = TOTAL EMPLOYMENT CHANGE BETWEEN 1980 AND 1986
TWAGINC = TOTAL WAGE-INCOME CHANGE BETWEEN 1980 AND 1986, 1986$, MILLIONS
WLS = WEIGHTED LEAST SQUARES
OTHER VARIABLES AS SPECIFIED EARLIER. LPOP80 = COUNTY POPULATION IN 1980
IN CASES WHERE METHOD WAS DEPENDENT VARIABLE/LPOP80, COEFFICIENTS WERE MULTIPLIED BY MEAN COUNTY POPULATION, I.E. 69676,
TO OBTAIN COEFFICIENTS COMPARABLE TO OTHER MODELS

Table 4.19, continued

MODEL 5

SEMP = 89 + 866 ROAD80** - 12,490 ELEC80 + 106 WATER - 8.7 APT + 20,073 PCOLL*** + 29 MSA** -0.00422 RECR - 98 TAX - 0.06838 SVCWAG80

ADJ. R**2=0.54   SSR=0.04339   SSE=0.03039   METHOD : DEPENDENT/LPOP80

MODEL 6

SEMP = 3234 + 6,003 G2LN80** - 34,639 ELEC80 + 111 WATER - 6.9 APT + 29,293 PCOLL*** + 37 MSA** -0.00609 RECR - 89TAX - 0.08731 SVCWAG80

ADJ. R**2=0.54   SSR=0.0431   SSE=0.0304   METHOD : DEPENDENT/LPOP80

MODEL 7

SWAGINC = -27 + 16 ROAD80*** - 733 ELEC80 + 2.79 WATER - 0.14 APT + 896 PCOLL*** + 0.72184 MSA*** -0.00007 RECR - 2.4960 TAX

ADJ. R**2=0.66   SSR=2.601E-6   SSE=1.238E-6   METHOD : DEPENDENT/LPOP80

MODEL 8

SWAGINC = 44*** + 91 G2LN80*** - 1,469 ELEC80*** + 2.096 WATER*** + 0.1728 APT*** + 161 PCOLL*** + 0.3697 MSA*** - 0.00002 RECR - 1.816 TAX

ADJ. R**2=0.36   SSR=3.31E-14   SSE=4.28E-14   METHOD : WLS, WEIGHT = LPOP80**2

NOTE : * = VARIABLE DIFFERENT FROM ZERO AT 10% LEVEL OF SIGNIFICANCE
** = VARIABLE DIFFERENT FROM ZERO AT 5% LEVEL OF SIGNIFICANCE
*** = VARIABLE DIFFERENT FROM ZERO AT 1% LEVEL OF SIGNIFICANCE
SEMP = SERVICE EMPLOYMENT CHANGE BETWEEN 1980 AND 1986
SWAGINC = SERVICE WAGE-INCOME CHANGE BETWEEN 1980 AND 1986, 1986$, MILLIONS
OTHER VARIABLES AS SPECIFIED EARLIER. LPOP80 = COUNTY POPULATION IN 1980
WLS = WEIGHTED LEAST SQUARES
IN CASES WHERE METHOD WAS DEPENDENT VARIABLE/LPOP80, COEFFICIENTS WERE MULTIPLIED BY MEAN COUNTY POPULATION, I.E. 59878,
TO OBTAIN COEFFICIENTS COMPARABLE TO OTHER MODELS

into a mean employment increase of 3 jobs for the mean county with an area of 391 square miles, over the nine year period of the study. Using the same assumptions, the following can be derived from the other models :

- the mean county had an average increase of 18 jobs associated with every mile increase in multi-lane highways;
- the mean county wage-income had an average increase of $66,500 (in 1988 dollars) associated with every mile increase in highways in the total system;
- the mean county wage-income had an average increase of $419,000 associated with every mile increase in multi-lane highways.

In the service industry sector, the associated values were as follows :

- the mean county had an average increase of 1.5 jobs associated with every mile increase in total highway mileage;
- the mean county had an average increase of 13 jobs associated with every mile increase in multi-lane highways;
- the mean county wage-income dollars had an average increase of $38,400 associated with every mile increase in highways on the total system;
- the mean county wage-income had an average increase of $207,000 associated with every mile increase in multi-lane highways.

These values are only estimated mean increases in variables representing economic development associated with increments in highway infrastructure, and should not be used for estimating economic growth overall or in individual counties. In Table 4.20, the 95 percent confidence intervals for the above-mentioned parameters are presented, also adjusted from highway mileage density to highway mileage in the relevant class of total mileage in 1980 or multi-lane mileage. The wide intervals of the parameters provide evidence of the large variances associated with the data.

It should also be noted that total employment had adjusted R^2 values that were much lower (0.14 to 0.18) than the service industry's values (0.38 to 0.65). This was most probably due to manufacturing sector changes, that could not be explained very well in earlier models, being included in the response variable of total industry employment and wage-income change. The result is that forecasts using the total industry model will have a much wider range at a constant level of confidence than the service industry model.

In summary, this part of the study did not present any models that incorporate highway condition or expenditures as a robust measure of economic development, for reasons that were stated earlier. The models that were developed for the total and service industry sectors could however be used to estimate the economic development impacts that the construction of a new

Table 4.20 Confidence Intervals for Highway Variables

DEPENDENT VARIABLE	INDEPENDENT VARIABLE	95% CONFIDENCE INTERVAL LOWER LIMIT	UPPER LIMIT
TOTEMP	ROAD80	0.59	5.65
TOTEMP	G2LN80	4.09	32.61
TOTWAGINC	ROAD80	16	116
TOTWAGINC	G2LN80	27	811
SVCEMP	ROAD80	0.32	2.57
SVCEMP	G2LN80	2.88	22.71
SVCWAGINC	ROAD80	18	60
SVCWAGINC	G2LN80	99	315

TOTEMP = TOTAL EMPLOYMENT CHANGE PER COUNTY, 1980-88
TOTWAGINC = TOTAL WAGE-INCOME CHANGE PER COUNTY, 1980-88
SVCEMP = SERVICE EMPLOYMENT CHANGE PER COUNTY, 1980-88
SVCWAGINC = SERVICE WAGE-INCOME CHANGE PER COUNTY, 1980-88

EMPLOYMENT CHANGES IN JOBS PER MILE
WAGE-INCOME CHANGES IN $'000 PER MILE, 1988 $
ROAD80 = TOTAL HIGHWAY MILEAGE PER COUNTY
G2LN80 = MULTI-LANE MILEAGE PER COUNTY

two-lane road, the upgrading of a two-lane to a four-lane road, or the construction of a new four-lane would have on a county in Indiana. The caveats that should however be kept in mind at all times are the limitations associated with the data and the methodology that were used.

CHAPTER 5

THE LOCATIONAL MODEL: CORRIDOR ANALYSIS

Four-lane highways have for long been viewed as a way of promoting economic development in a region. From the literature review for this study it was clear that especially in location theory, prospective industries view the existence of this type of highway facility as an important factor when making decisions whether to locate at a specific site or in a region.

In this regard, four-lane highways in the state of Indiana were analyzed to see what the impact, if any, had been of the construction of specific highways on the region. The analysis was aimed at investigating changes in the employment levels of counties in the region of the highway construction. Initially, a total of nine four-lane highways in the state were identified. These highways are shown in Figure 5.1, and were the following :

- I-64, from the Illinois-Indiana State line to the Indiana-Kentucky State line;
- I-70, from the Marion-Hancock County line to the Indiana-Ohio State line;

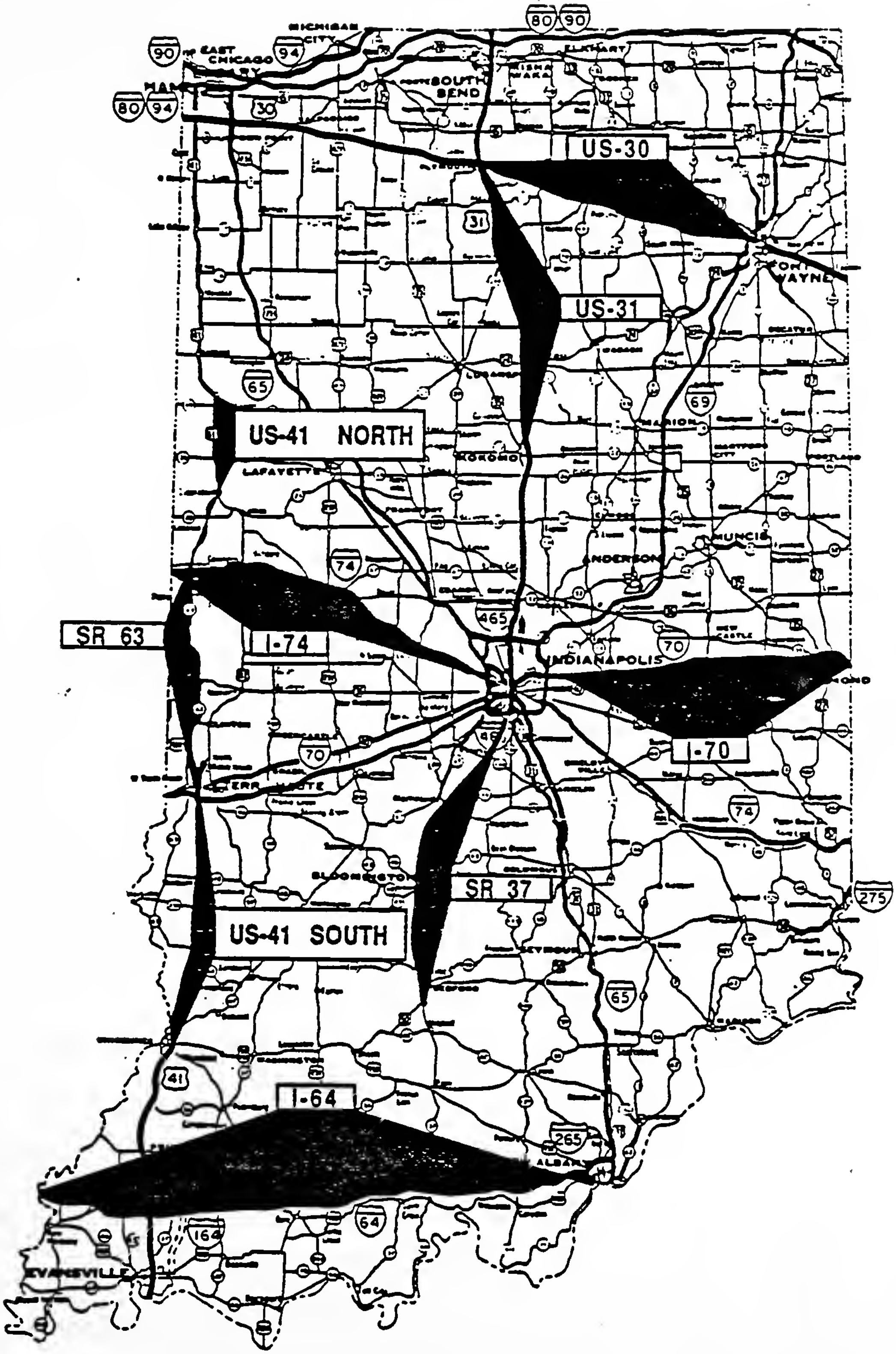


Figure 5.1 Four-Lane Sections Identified for Corridor Analysis

- I-74, from the Illinois-Indiana State line to the Hendricks-Marion County line;
- US-30, from US-31 at Plymouth to I-69 at Fort Wayne;
- US-31, from Kokomo to Plymouth;
- US-41 North, from SR 63 to US-52;
- US-41 South, from Vincennes to I-70 at Terre Haute;
- SR 37, from Bedford to the Johnson-Marion County line, and
- SR 63, from Terre Haute to US-41 in Warren County.

Several of these highways were converted to four-lane highways under the so-called "Killer Road Program" that was undertaken under the auspices of then Indiana Governor Edgar J. Whitcomb, between 1969 and 1973. The purpose of this program was to increase user safety on highways in Indiana with high accident rates, without any specific emphasis on economic development [INDOT 1972]. Where specific highway sections were constructed under this program, it was mentioned as relevant. For the purpose of determining the effects that the construction of these highways had on the region in which they are located, an analysis methodology had to be defined, data were collected, the analyses were performed, and conclusions were made.

It has been evident from earlier sections of the study that there is difficulty involved in determining and quantifying the effects that highways have on regional economic development. In this part of the study, which looked at specific highway sections within a region and their economic

impact on the region, the same problems as previously defined would be applicable. Many factors, both local and state- or nation-wide, would affect the economic development in a region. Also, in order to determine the effects that a specific highway's construction had on a region, that region would have to be contrasted with other regions where all factors were the same, and where this infrastructure expenditure did not take place. The fact that it is impossible to create or simulate these conditions, complicated the analysis.

Descriptive and comparative statistics were used in an attempt to identify trends. An analysis methodology was defined in terms of the location of a highway section under consideration. The level of analysis was the county level, as data over the time period which varied from 1950 to 1981 depending on the highway section considered, were readily available at that level. The measure of economic development was the employment levels in a county, in the classifications of total, manufacturing, and service employment as defined earlier in this study.

The analysis was done on a before-after basis (employment before a highway was constructed, contrasted to afterwards), and a with and without basis (contrasting counties with highway construction to adjacent counties, and to the state of Indiana as a whole). The specific methodology adopted for the

analysis of each section will be presented later in this chapter.

Data Collection

Initially, data were collected on all highway sections noted earlier. Construction records were collected on the actual four-lane construction time periods of these highways. Although this construction was often the addition of two lanes to an existing two-lane highway, the original two-lane construction was not considered, but just the time period when the facility was upgraded to four lanes. It soon became clear that some of the nine sections under consideration were not built continuously, but rather in sections of which the construction spanned several years. For analysis purposes, continuous sections were identified and are presented in Figure 5.2, which shows the construction data, by county, for each of the nine sections of four-lane highways. These sections were viewed individually in the rest of the analysis.

Employment data were also collected, once analysis sections had been identified, for both primary and secondary counties. The source of these data was County Business Patterns from 1950 to 1984. Data before 1950 were not available, but this affected only one section.

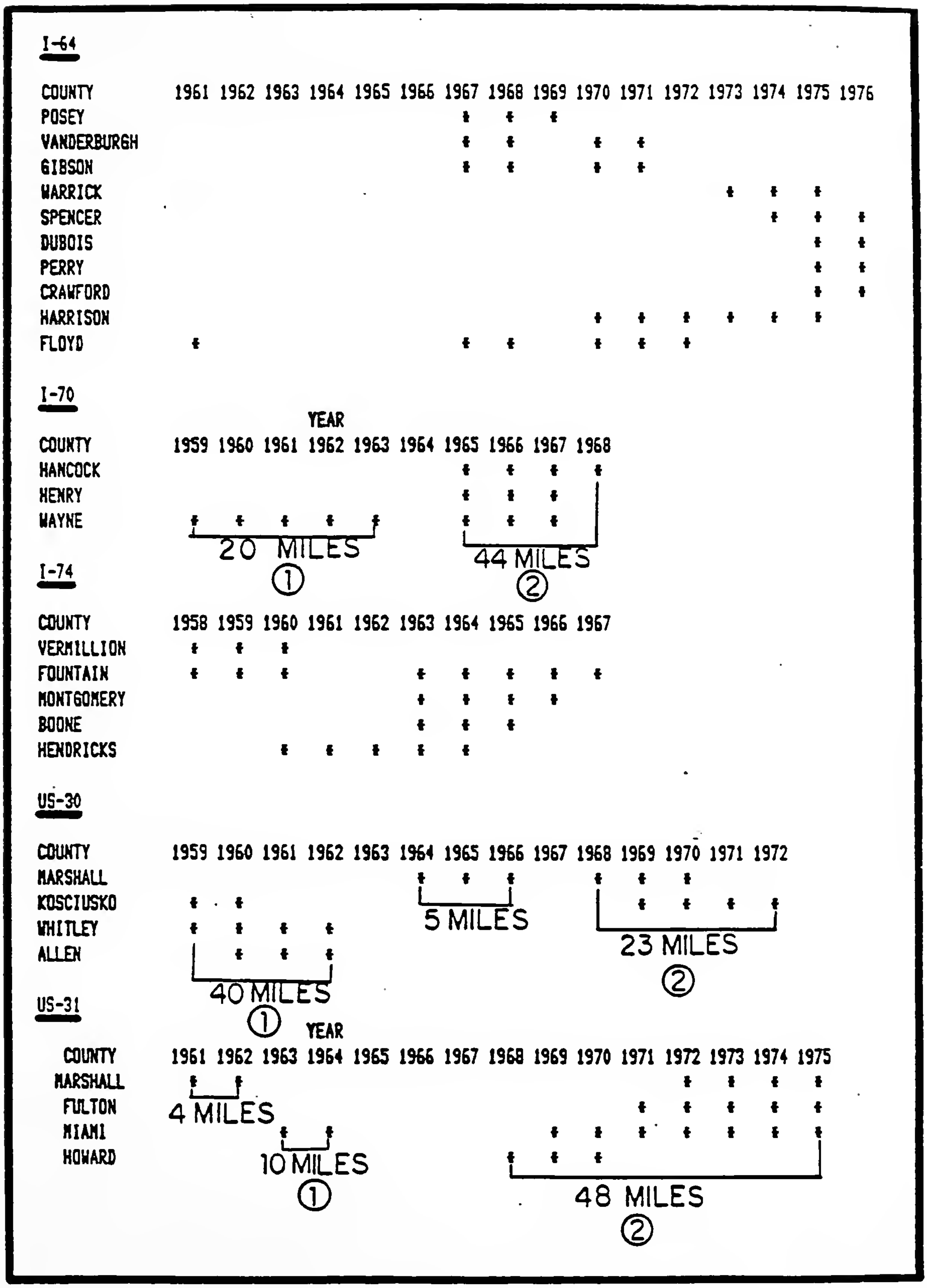


Figure 5.2 Four-Lane Section Construction Data

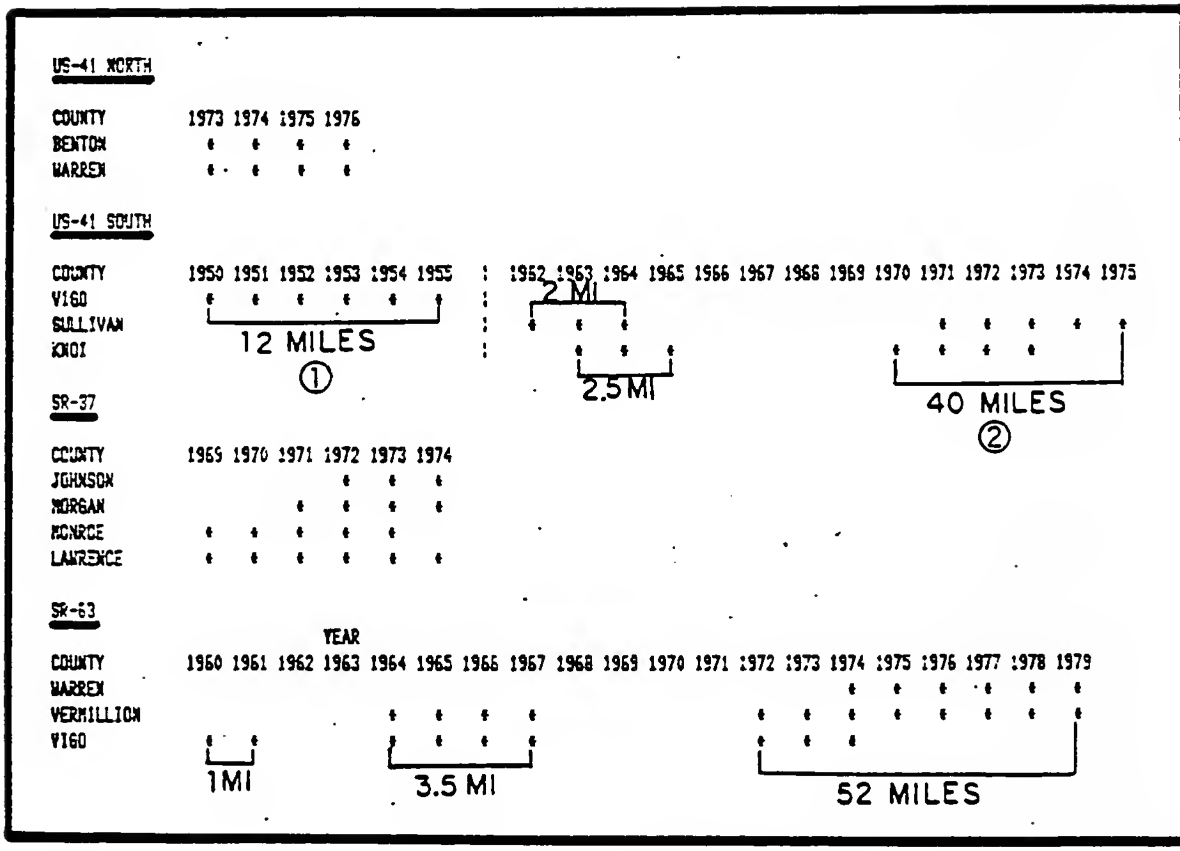


Figure 5.2, continued

Analysis Methodology

A structured methodology was followed to analyze each road section. If a highway was constructed in a county, that county was defined as a primary county. All directly adjacent counties were defined as secondary counties. Figure 5.3 illustrates this principle. Primary counties continued to have this classification until the end of the construction period of the highway section, even though in-county construction could be completed before the whole section, assuming that benefits from the highway construction would continue after the construction was completed.

Figure 5.4 presents a flow diagram of the analysis methodology that was used for each road section. After four-lane sections had been identified and data collected, year-to-year changes in employment in the three sectors were determined for all primary or secondary counties combined, as well as total annual average employment levels per county for each of the three groups of primary and secondary counties, and Indiana. This was done for the time period identified for each section's construction, as well as for the period preceding and following construction. These data were presented in figures to show employment trends graphically.

The next step was to determine changes over the long and the short term. The long term was a period considered from five

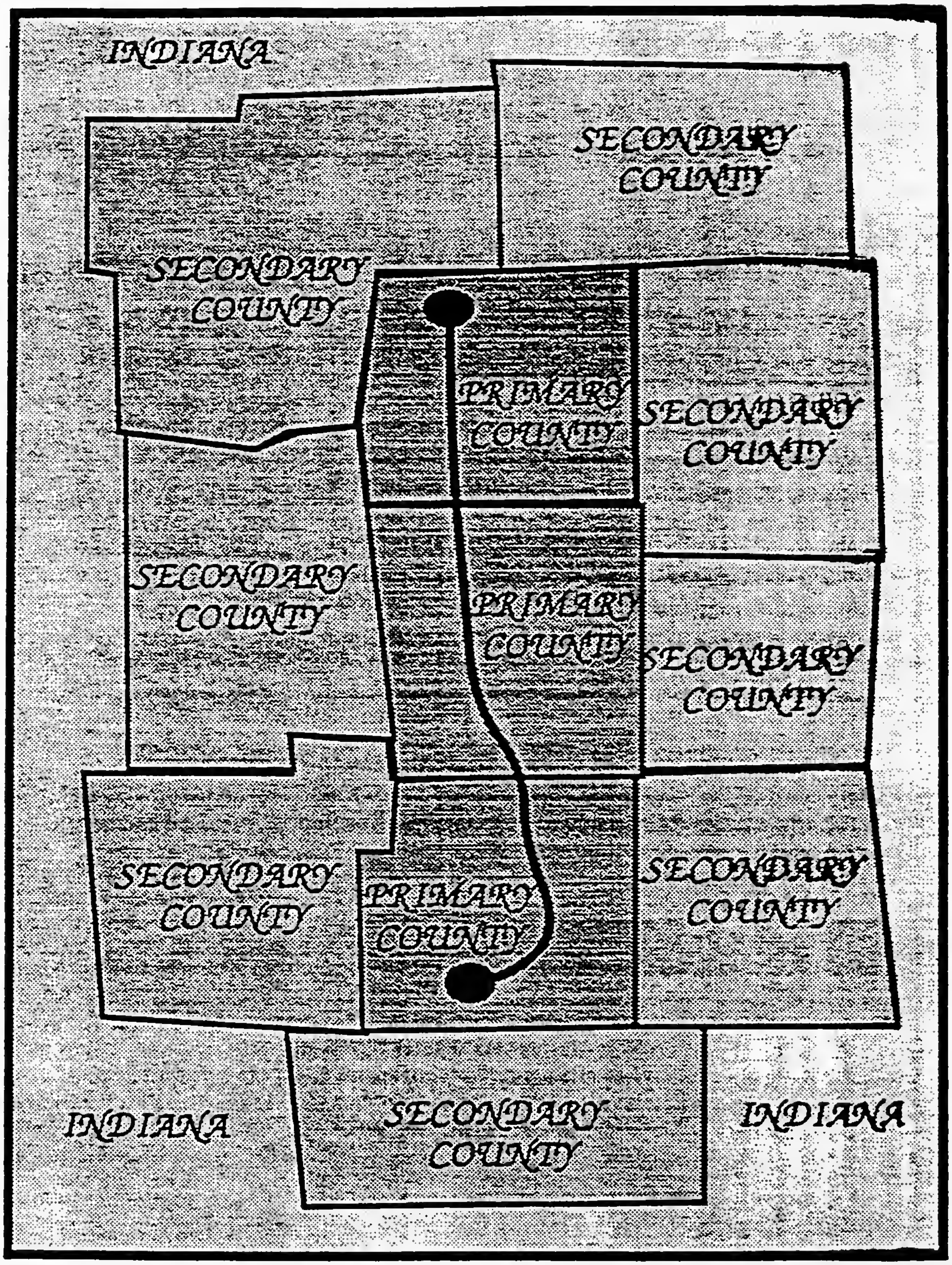


Figure 5.3 Primary and Secondary County Definition

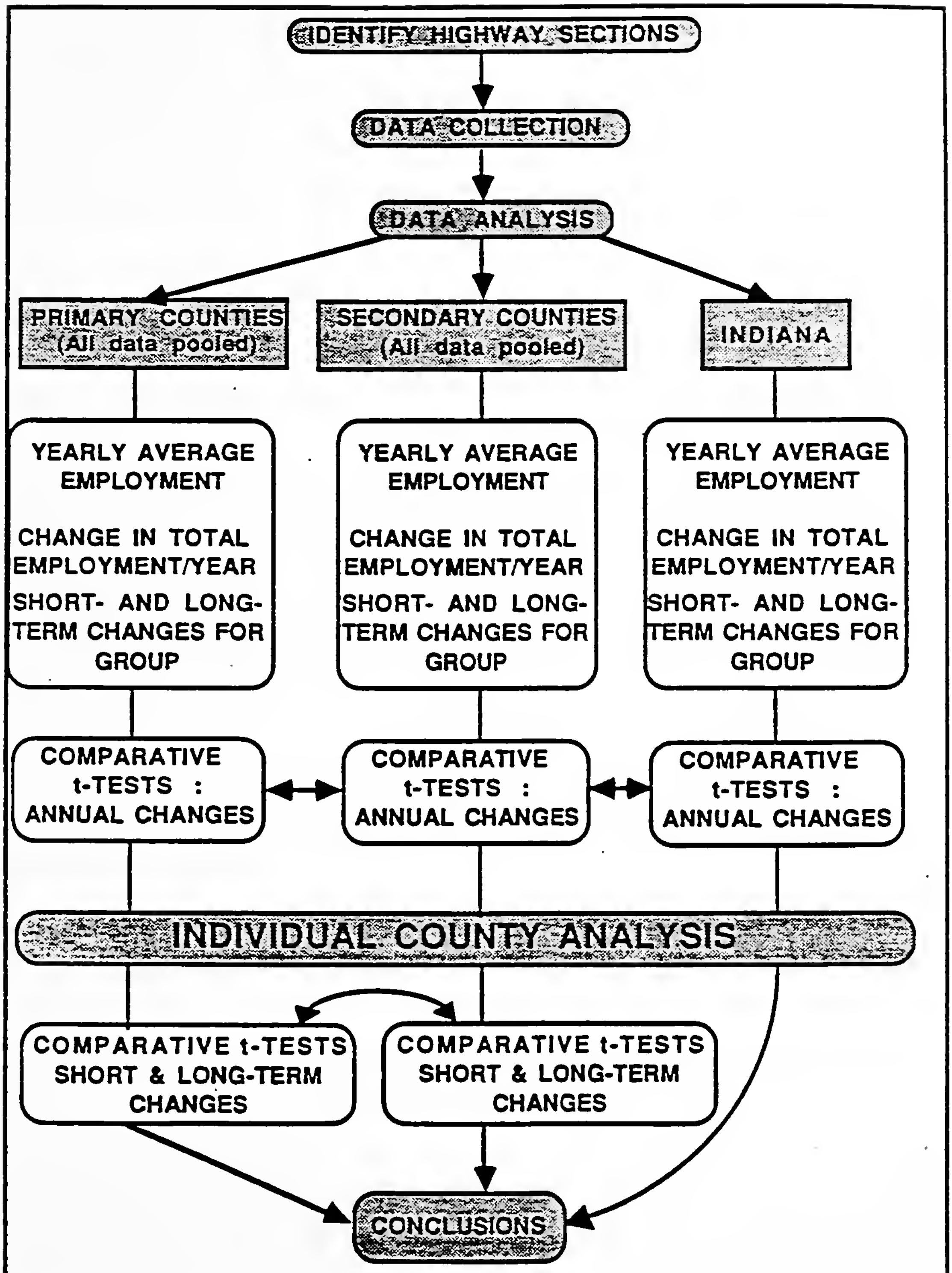


Figure 5.4 Highway Corridor Analysis Methodology

years before construction started, until five years afterwards, depending on data availability. The <u>short term</u> was regarded as the actual construction period. Initially, data for all counties in a primary or secondary group were combined, and long- and short-term changes were determined. These data are also presented graphically for each road section. Averages and standard deviations were determined for comparative purposes, and two-sided t-tests were used to investigate if the average annual change in employment of primary counties were significantly different from secondary counties, and also from the state of Indiana. These tests were performed at the 10 percent level of significance and were repeated for secondary counties contrasted to Indiana. The hypotheses that were tested were:

1) $H_o : u_p = u_s$

$H_A : u_p \neq u_s$,

2) $H_o : u_p = u_i$

$H_A : u_p \neq u_i$, and

3) $H_o : u_s = u_i$

$H_A : u_s \neq u_i$,

where u_p, u_s, and u_i were the mean employment changes from year-to-year over the time period as relevant in respectively primary and secondary counties, and in Indiana.

In the individual county analysis, long- and short-term changes for individual counties within the primary or secondary group were determined. Two-sided t-tests were used to determine if the mean increase in employment in primary counties were statistically significantly higher than in secondary counties at the 10 percent level of significance, under the hypothesis :

$$H_o : u_p = u_s$$

$$H_A : u_p \neq u_s,$$

where u_p is the mean change in employment for all primary counties, and u_s is the mean change for all secondary counties. This analysis was also performed over the short term as well as for the long term.

The analysis methodology was executed for each of the sections that were identified. If a significant difference was detected in any case, the two-sided p-value was determined from the test, and presented to indicate the level of significance.

Results and Discussion

In this section, each of the nine four-lane highways and their individual sections, as applicable, will be discussed.

Analysis of I-64

Figure 5.5 shows the location of I-64, with the primary and secondary counties used in the analysis of this section. The highway was built from 1967 to 1976, except for a small portion close to the Indiana-Kentucky state line that was four-laned in the early 1960s. Figure 5.6 presents the year-to-year change and average total employment in primary and secondary counties as well as for the average county in Indiana, over the construction period and for 5 years before and after, as well as employment changes in the total, manufacturing and service sector in the long and short term as defined earlier. It is evident from these graphs that primary counties as a whole had a higher average employment than secondary counties over the time period, but both categories were below the state-wide average. In almost all cases the annual employment changes in primary counties seemed to be less than the changes in secondary counties, but still higher than for the state average. Primary counties seemed however to overtake secondary counties in economic growth at the end of the project.

This trend was similar over the long and the short term, i.e. between 1962 and 1981, and 1967 and 1976 respectively.

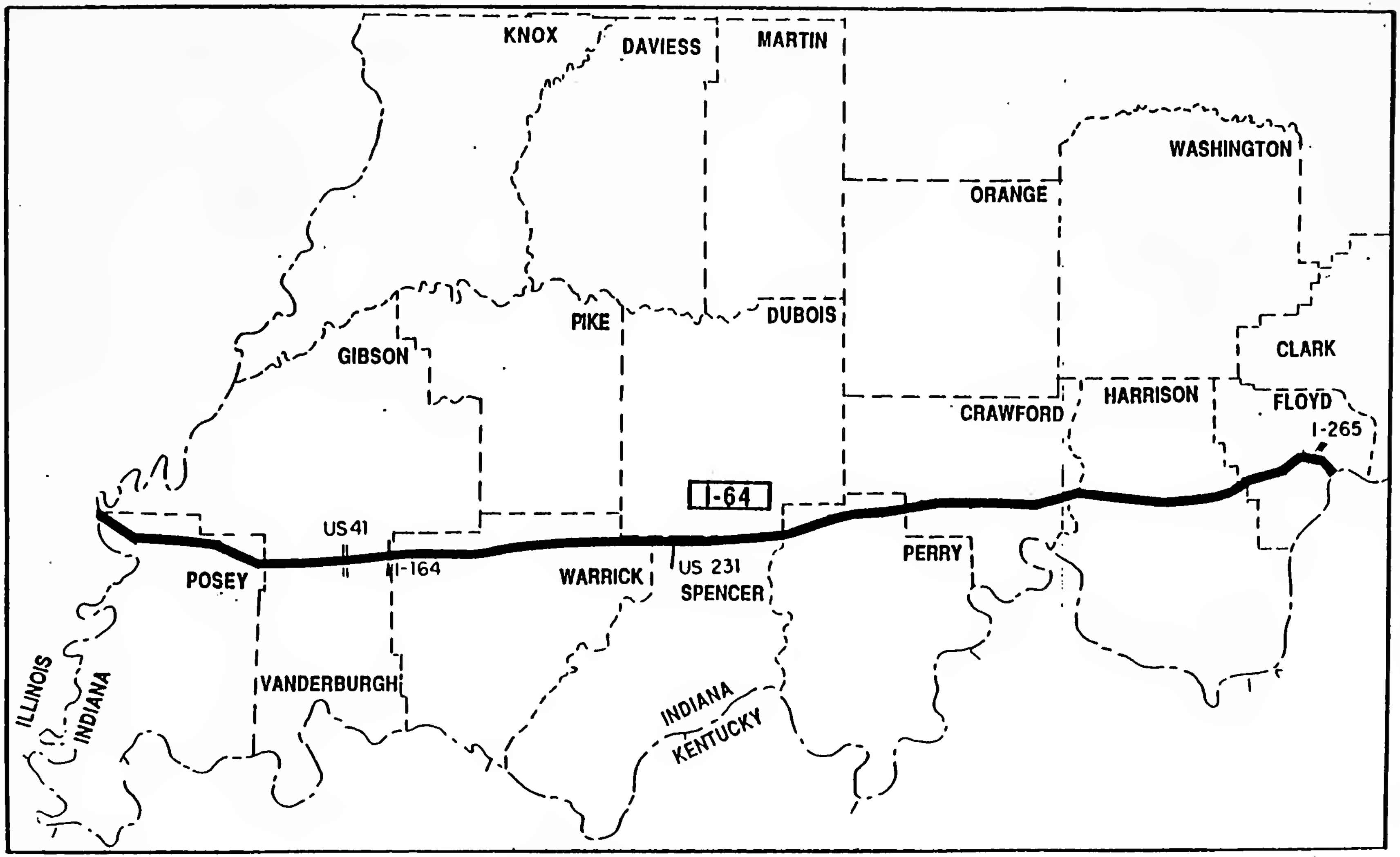


Figure 5.5 Primary and Secondary Counties: I-64

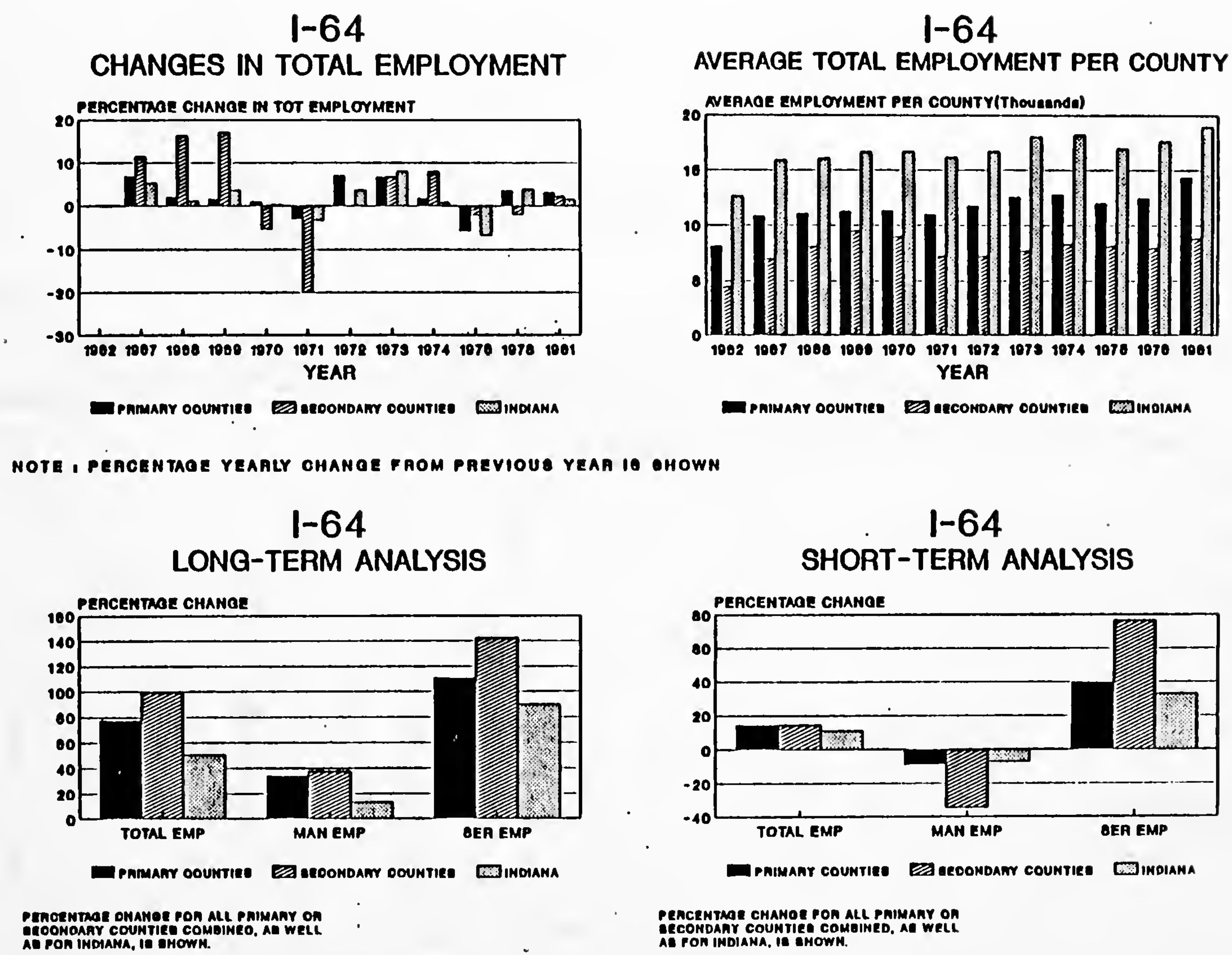


Figure 5.6 Annual, Long- and Short-Term Employment Changes and Annual Employment Base: I-64

In the short term or over the years of construction, the total employment change in both types of counties combined was about the same, and higher than the state of Indiana. Individual trends in manufacturing and service industries can also be seen. Over the long term, primary counties lagged behind secondary counties in overall employment, but both were leading the state due to higher percentage increases in service and manufacturing sector growth.

Table 5.1 gives information concerning comparative data and t-tests performed for year-to-year changes in all three types of counties, for the three sectors. Although primary and secondary counties as separate groups had higher average changes than Indiana's average county in almost all cases, this difference was not statistically significant in any sector. Results from t-tests for long- and short-term changes in individual county employment levels are also presented, and show that although the average change in all cases was higher in primary counties than in secondary counties, this difference was not statistically significant in any sector. It should be noted that in almost all cases, the average employment increases in both primary and secondary counties were higher than the average state increases. Clark County, in the secondary county group, showed a total employment increase of more than 200 percent in the long term, which was much higher than the rest of the counties in the group.

Table 5.1 Results from Comparative Data and t-Tests: I-64

RESULTS OF COMPARATIVE t-TESTS : I-64

TESTS FOR YEARLY CHANGES PER COUNTY GROUP : POOLED DATA

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	2.20%	0.17%	3.92%
	ST DEV	3.97%	6.80%	1.96%
	N	11	11	11
SECONDARY :	AVG	2.96%	-0.47%	6.09%
	ST DEV	10.66%	18.46%	4.95%
	N	11	11	11
INDIANA :	AVG	1.63%	-0.11%	3.35%
	ST DEV	4.02%	5.67%	2.18%
	N	11	11	11
P-VALUES :				
PR VS SEC		>0.10	>0.10	>0.10
PR VS INDIANA		>0.10	>0.10	>0.10
SEC VS INDIANA		>0.10	>0.10	>0.10

TESTS FOR INDIVIDUAL COUNTIES IN A GROUP

LONG-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	113.09%	129.56%	136.95%
	ST DEV	84.92%	165.52%	70.37%
	N	10	10	10
SECONDARY :	AVG	73.66%	32.53%	89.53%
	ST DEV	71.81%	54.81%	138.05%
	N	5	5	5
INDIANA		50.52%	13.16%	89.61%
t-TEST P-VALUE		>0.10	>0.10	>0.10

SHORT-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	28.02%	22.88%	55.39%
	ST DEV	32.00%	62.33%	21.50%
	N	10	10	8
SECONDARY :	AVG	16.59%	-28.01%	50.38%
	ST DEV	30.52%	22.67%	54.25%
	N	5	4	5
INDIANA		10.93%	-6.97%	32.84%
t-TEST P-VALUE		>0.10	>0.10	>0.10

NOTE : A P-VALUE OF HIGHER THAN 0.10 INDICATES THAT THERE WAS NO SIGNIFICANT DIFFERENCE IN EMPLOYMENT GROWTH BETWEEN THE TWO GROUPS. A POSITIVE P-VALUE OF LESS THAN 0.10 INDICATES THAT THE FIRST GROUP HAD A SIGNIFICANTLY HIGHER EMPLOYMENT GROWTH THAN THE SECOND GROUP, AND A NEGATIVE VALUE THE OPPOSITE.
TOTAL, MANUF AND SERVICE INDICATE RESPECTIVELY DATA CONCERNING TOTAL, MANUFACTURING AND SERVICE EMPLOYMENT.

Analysis of I-70

Figure 5.7 provides the construction and county data for the four-lane construction of I-70. The highway was built in two continuous sections, namely one section of 20 miles next to the Ohio state line from 1959 to 1963, and the other a section of 44 miles from 1965 to 1968. These two sections will be labeled I-70 section 1 and I-70 section 2 respectively ,in the following discussion.

I-70 Section 1

Employment data for all 5 years of construction, namely 1959 to 1963, were not available, and 1964 was used as the contract completion period. Figure 5.8 presents employment base and change data for the two groups of counties involved, as well as Indiana. It is evident that the employment base in Wayne County, the only primary county, was greater than the average base in either secondary or overall Indiana counties. Although year-to-year employment growth in the primary county was initially higher than in the secondary counties, it was lower towards the end of the project, also when compared to the state. The long- and short-term analyses show however that in almost all cases and sectors Wayne County had a higher employment growth than the pooled growth secondary counties. This trend was similar when compared to Indiana, in all

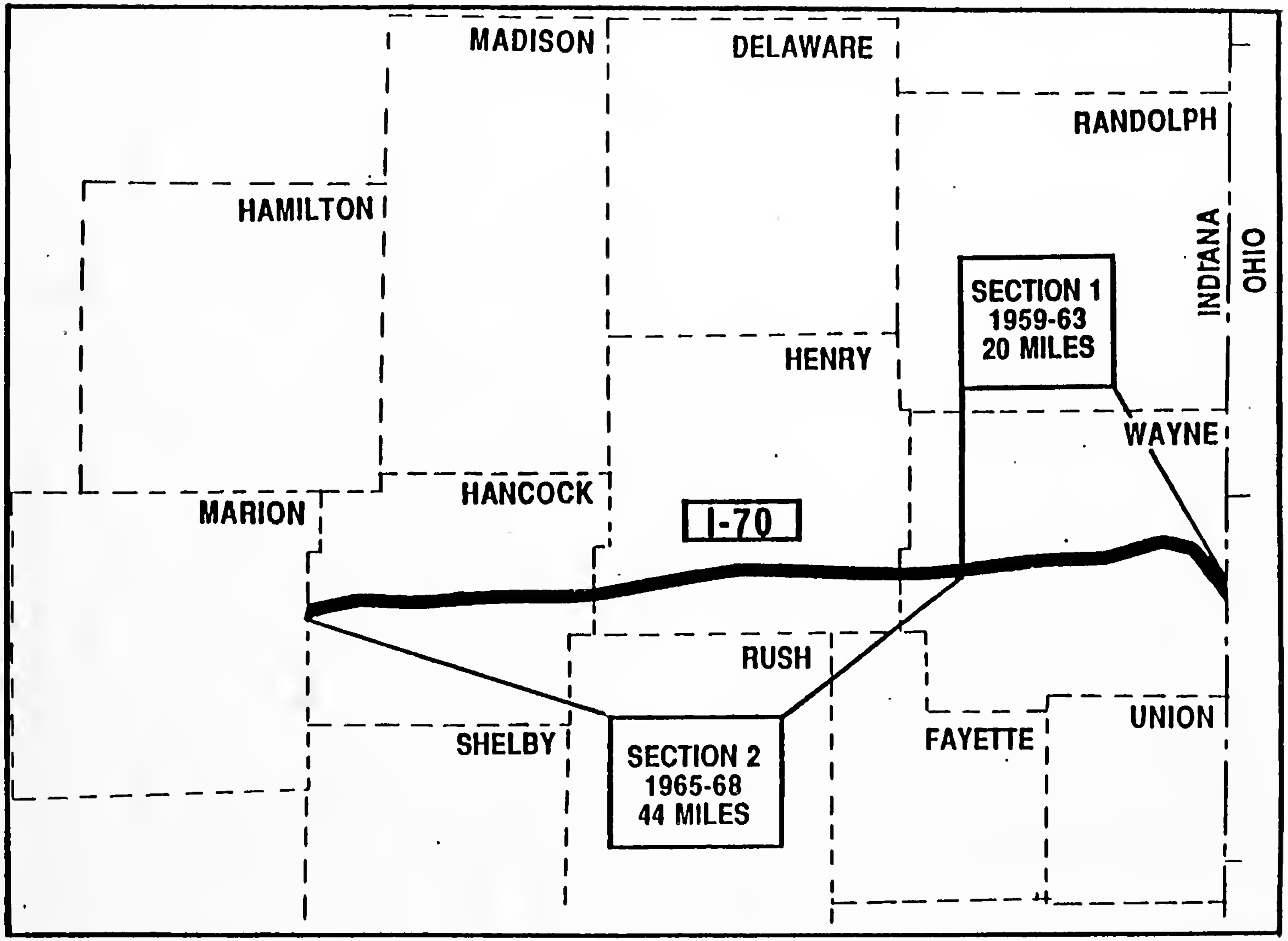


Figure 5.7 Primary and Secondary Counties: I-70

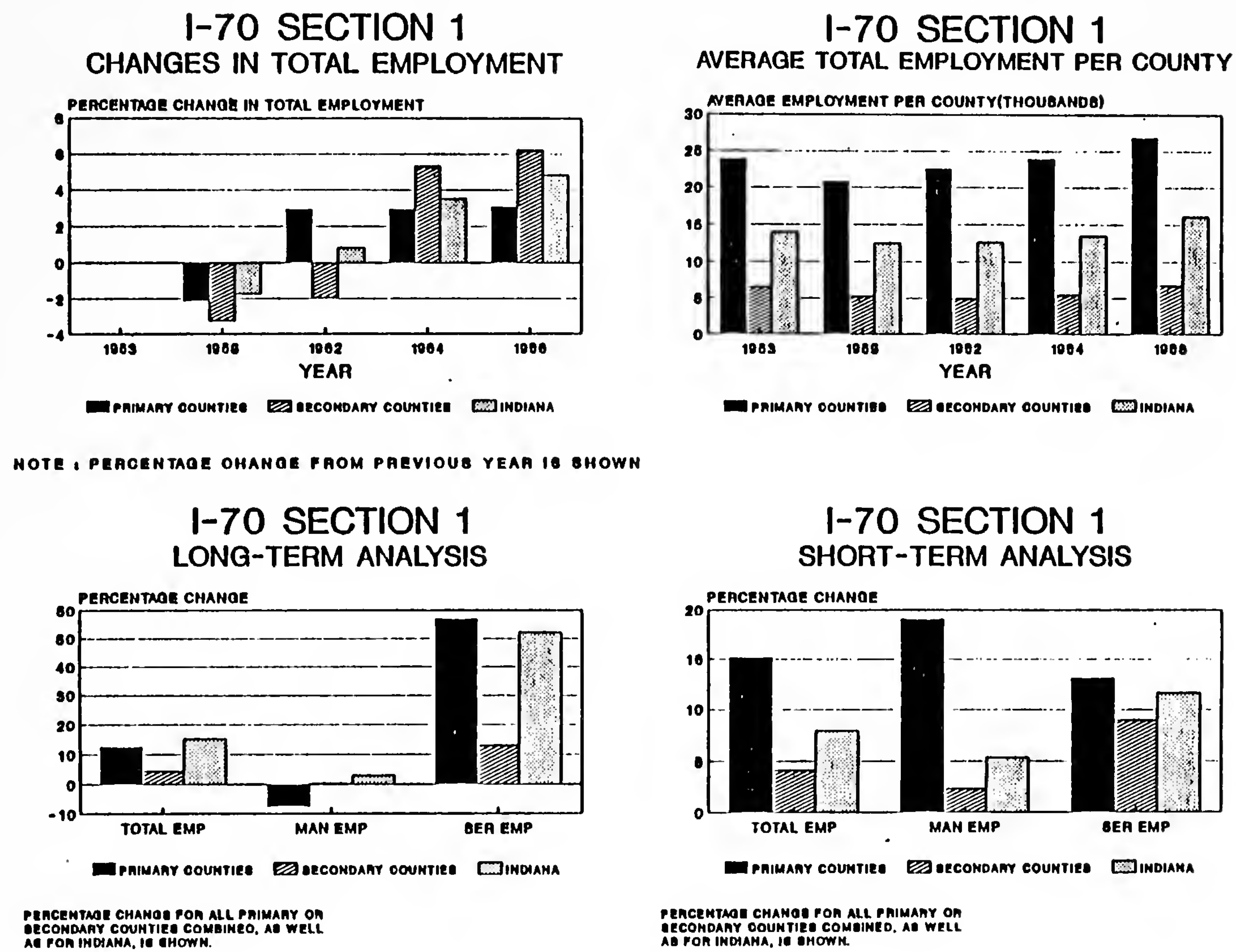


Figure 5.8 Annual, Long- and Short-Term Employment Changes and Annual Employment Base: I-70 Section 1

sectors in the short run, but only in the service sector in the long run.

Comparative statistics and t-test results are presented in Table 5.2. Yearly total employment changes were lower in primary and secondary counties than in the state. None of the mean changes in the three groups and sectors differed significantly. Concerning tests for the difference in individual county employment changes over the short and long term, it appears that in the short term, primary counties had a higher increase than secondary counties or the state, but this was not statistically significant in any sector. Over the long run, this trend continued only in the service sector, where Wayne County had a significantly higher increase than the secondary counties. A drastic decline of about 30 percent in the manufacturing industry in Henry County between 1953 and 1959 affected these two counties' averages in the long term.

<u>I-70 Section 2</u>

This section spans a length of over 40 miles in Hancock, Henry, and Wayne Counties. In Figure 5.9, employment data are presented graphically. The average primary county had a slightly lower employment base throughout the time period than secondary counties or the average Indiana county. Initial year-to-year employment changes were higher in primary counties, but were lower relative to other groups as the

Table 5.2 Results from Comparative Data and t-Tests: I-70 Section 1

RESULTS OF COMPARATIVE t-TESTS : I-70 SECTION 1

TESTS FOR YEARLY CHANGES PER COUNTY GROUP : POOLED DATA

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	1.69%	0.86%	3.53%
	ST DEV	2.56%	4.07%	2.69%
	N	4	4	4
SECONDARY :	AVG	1.58%	1.63%	1.68%
	ST DEV	4.88%	5.93%	3.14%
	N	4	4	4
INDIANA :	AVG	1.85%	1.06%	3.09%
	ST DEV	2.91%	3.09%	1.75%
	N	4	4	4
P-VALUES :				
PR VS SEC		>0.10	>0.10	>0.10
PR VS INDIANA		>0.10	>0.10	>0.10
SEC VS INDIANA		>0.10	>0.10	>0.10

TESTS FOR INDIVIDUAL COUNTIES IN A GROUP

LONG-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	12.60%	-7.44%	57.02%
	ST DEV	0.00%	0.00%	0.00%
	N	1	1	1
SECONDARY :	AVG	14.01%	27.26%	12.18%
	ST DEV	18.62%	50.08%	4.13%
	N	4	4	4
INDIANA		15.24%	3.13%	52.07%
t-TEST P-VALUE		>0.10	>0.10	0.0017

SHORT-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	15.16%	19.08%	13.07%
	ST DEV	0.00%	0.00%	0.00%
	N	1	1	1
SECONDARY :	AVG	1.44%	-6.88%	6.79%
	ST DEV	6.17%	19.08%	9.67%
	N	4	4	4
INDIANA		7.91%	5.34%	11.59%
t-TEST P-VALUE		>0.10	>0.10	>0.10

NOTE : A P-VALUE OF HIGHER THAN 0.10 INDICATES THAT THERE WAS NO SIGNIFICANT DIFFERENCE IN EMPLOYMENT GROWTH BETWEEN THE TWO GROUPS. A POSITIVE P-VALUE OF LESS THAN 0.10 INDICATES THAT THE FIRST GROUP HAD A SIGNIFICANTLY HIGHER EMPLOYMENT GROWTH THAN THE SECOND GROUP, AND A NEGATIVE VALUE THE OPPOSITE.
TOTAL, MANUF AND SERVICE INDICATE RESPECTIVELY DATA CONCERNING TOTAL, MANUFACTURING AND SERVICE EMPLOYMENT.

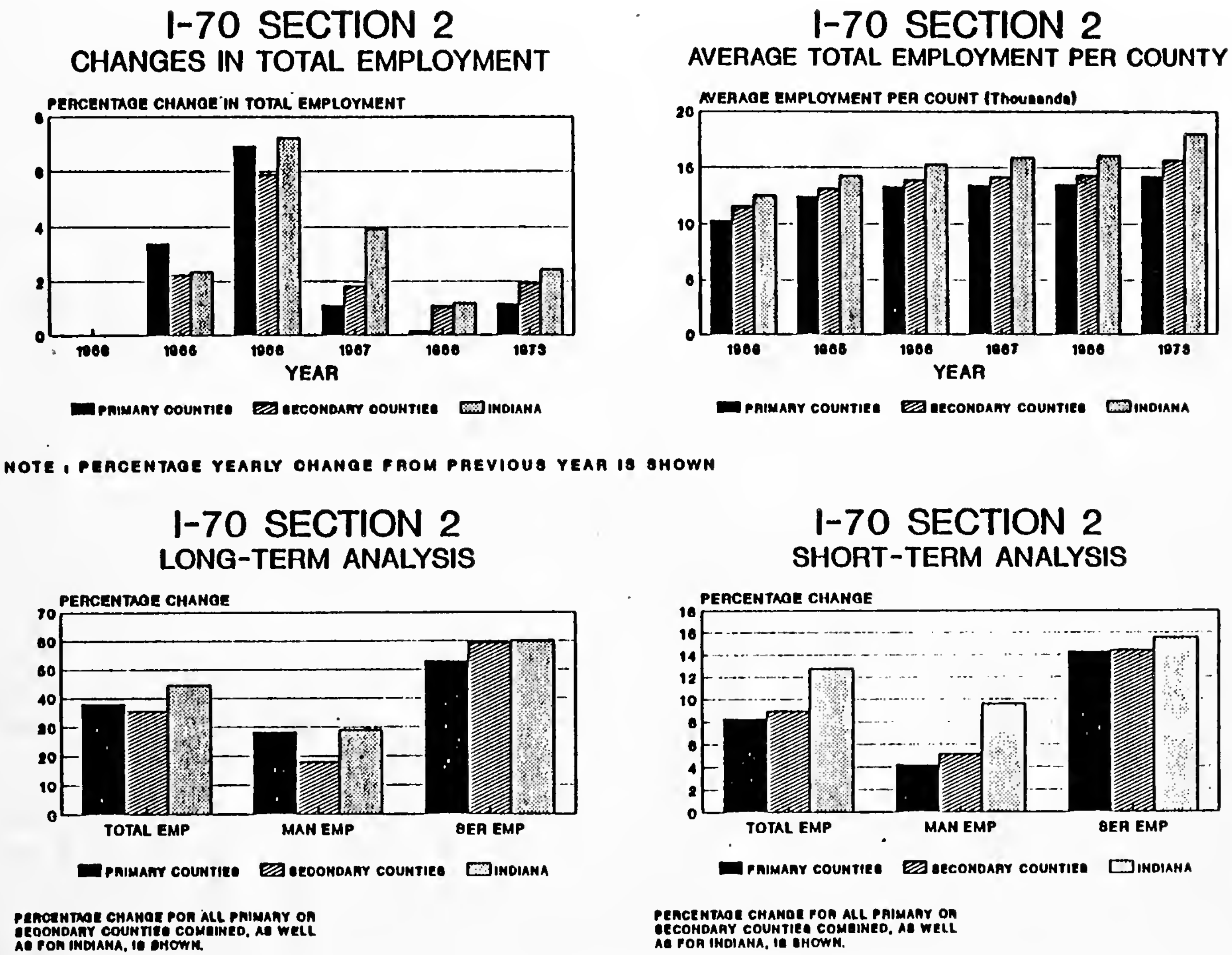


Figure 5.9 Annual, Long- and Short-Term Employment Changes and Annual Employment Base: I-70 Section 2

project proceeded. Over the short term, primary counties as a group showed a slightly lower increase in employment in all sectors when compared to the other county groups, but in the long term this increase was higher than secondary counties in the manufacturing employment and total employment sectors. Long-term service employment change was less than secondary counties and the state.

Table 5.3 gives comparative statistics and results from the comparative t-tests. The average annual changes in all three sectors were lower in primary and secondary counties than in the state, but were not significantly different in a statistical sense. Over the long term, individual primary counties on average had a higher increase in employment than secondary counties and the state in all three sectors, but this was reversed in the short run. None of the t-tests showed however that there had been a statistically significant difference between the mean increases of any two groups of counties, in any sector.

Analysis of I-74

This section is situated in the west-central part of the state, and was four-laned between 1959 and 1967, in continuous construction projects. The location of this segment of the highway is presented in Figure 5.10, and the primary and secondary counties can be identified. Employment data are

Table 5.3 Results from Comparative Data and t-Tests: I-70 Section 2

RESULTS OF COMPARATIVE t-TESTS : I-70 SECTION 2

TESTS FOR YEARLY CHANGES PER COUNTY GROUP : POOLED DATA

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	2.56%	1.65%	3.91%
	ST DEV	2.72%	3.63%	3.45%
	N	5	5	5
SECONDARY :	AVG	2.59%	1.44%	4.10%
	ST DEV	1.89%	1.91%	1.72%
	N	5	5	5
INDIANA :	AVG	3.43%	2.50%	4.27%
	ST DEV	2.34%	3.50%	1.40%
	N	5	5	5
P-VALUES :				
PR VS SEC		>0.10	>0.10	>0.10
PR VS INDIANA		>0.10	>0.10	>0.10
SEC VS INDIANA		>0.10	>0.10	>0.10

TESTS FOR INDIVIDUAL COUNTIES IN A GROUP

LONG-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	59.17%	67.30%	63.71%
	ST DEV	41.20%	74.75%	19.45%
	N	3	3	3
SECONDARY :	AVG	46.94%	58.27%	57.09%
	ST DEV	25.79%	95.17%	30.88%
	N	8	8	8
INDIANA		44.38%	28.92%	60.04%
t-TEST P-VALUE		>0.10	>0.10	>0.10

SHORT-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	8.12%	8.16%	10.06%
	ST DEV	0.37%	6.73%	8.76%
	N	3	3	3
SECONDARY :	AVG	16.03%	22.99%	20.64%
	ST DEV	16.25%	39.32%	18.96%
	N	8	8	8
INDIANA		12.75%	9.58%	15.55%
t-TEST P-VALUE		>0.10	>0.10	>0.10

NOTE : A P-VALUE OF HIGHER THAN 0.10 INDICATES THAT THERE WAS NO SIGNIFICANT DIFFERENCE IN EMPLOYMENT GROWTH BETWEEN THE TWO GROUPS. A POSITIVE P-VALUE OF LESS THAN 0.10 INDICATES THAT THE FIRST GROUP HAD A SIGNIFICANTLY HIGHER EMPLOYMENT GROWTH THAN THE SECOND GROUP, AND A NEGATIVE VALUE THE OPPOSITE.
TOTAL, MANUF AND SERVICE INDICATE RESPECTIVELY DATA CONCERNING TOTAL, MANUFACTURING AND SERVICE EMPLOYMENT.

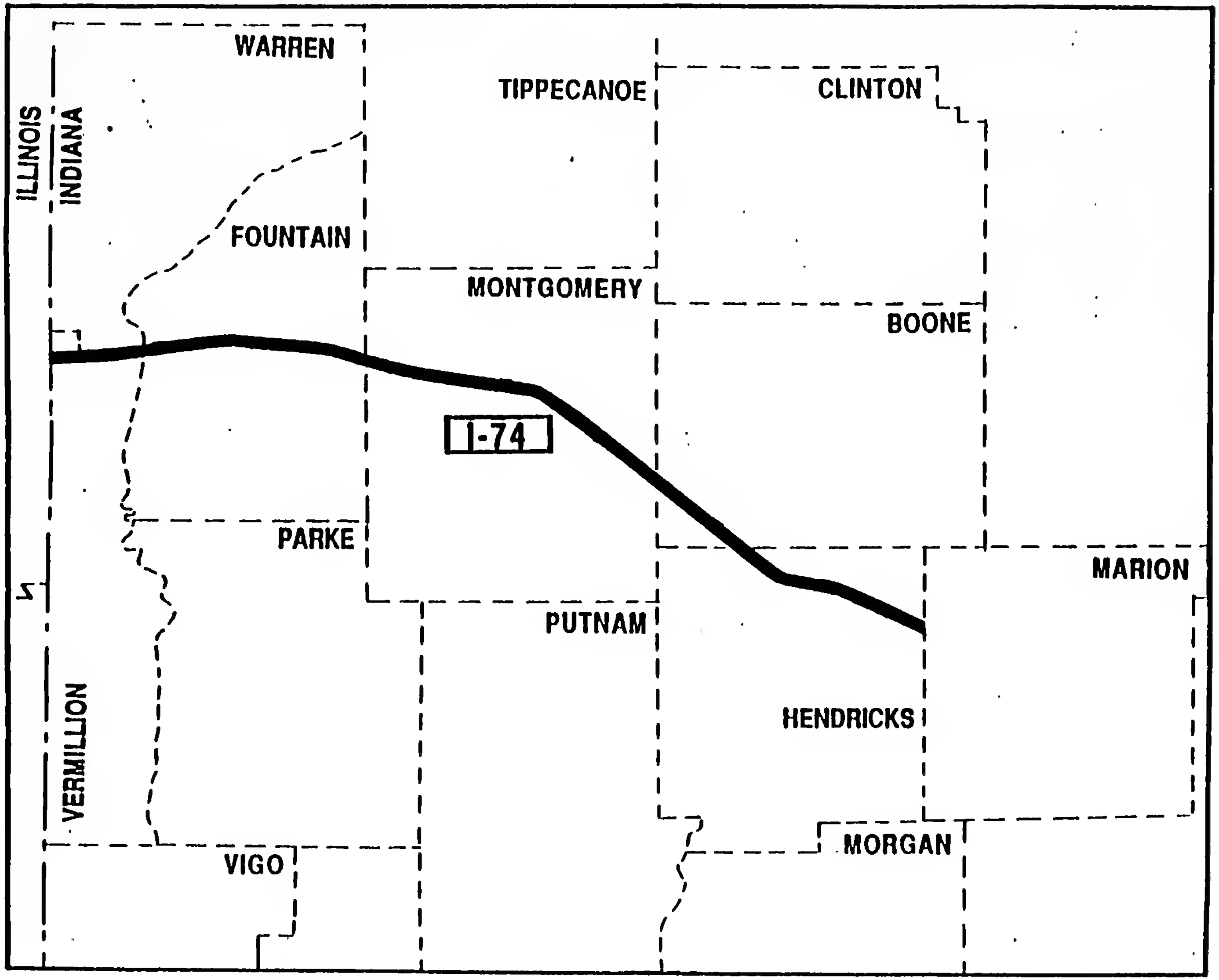


Figure 5.10 Primary and Secondary Counties: I-74

given graphically in Figure 5.11, and it is evident that primary counties had on average less than half the employment base of secondary counties or the average county in the state. In initial years, the yearly change in employment in primary counties was higher than in the other two groups, then lagged behind both towards the end of the project, but was again higher for the five year period after construction was completed.

Also in this figure, the employment changes for all counties in a group over the long and the short term can be seen. Total employment changes over the short term were about the same in all three groups of counties, but were the highest in primary counties over the long term, and also higher in secondary counties than in the state as a whole. Other sector changes varied as seen.

Comparative data and t-test results are given in Table 5.4. None of the t-tests for year-to-year changes between groups indicated significant differences, as these changes were fairly similar in primary and secondary counties, and slightly higher than the state's increase in most cases. In the short term, primary counties lagged secondary counties in all three sectors, but secondary counties had a higher percentage change than Indiana's average county. Over the long run however, primary counties had a higher increase in employment in the total and manufacturing sectors than secondary counties and

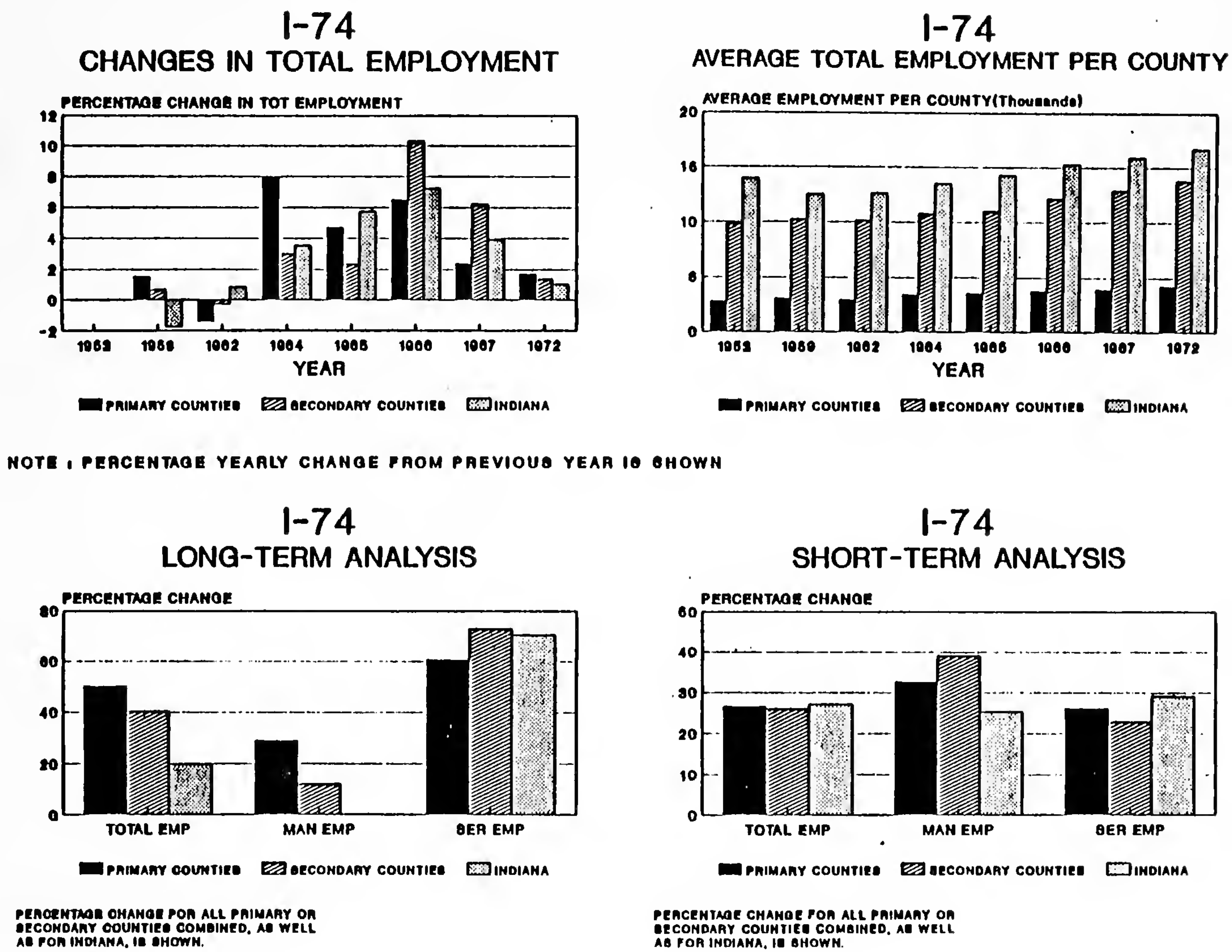


Figure 5.11 Annual, Long- and Short-Term Employment Changes and Annual Employment Base: I-74

Table 5.4 Results from Comparative Data and t-Tests: I-74

RESULTS OF COMPARATIVE t-TESTS : I-74

TESTS FOR YEARLY CHANGES PER COUNTY GROUP : POOLED DATA

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	3.33%	3.70%	3.31%
	ST DEV	3.20%	4.84%	3.08%
	N	7	7	7
SECONDARY :	AVG	3.38%	4.10%	3.33%
	ST DEV	3.71%	7.03%	1.77%
	N	7	7	7
INDIANA :	AVG	2.93%	2.43%	3.65%
	ST DEV	3.10%	3.85%	1.71%
	N	7	7	7
P-VALUES :				
PR VS SEC		>0.10	>0.10	>0.10
PR VS INDIANA		>0.10	>0.10	>0.10
SEC VS INDIANA		>0.10	>0.10	>0.10

TESTS FOR INDIVIDUAL COUNTIES IN A GROUP

LONG-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	73.62%	47.98%	55.29%
	ST DEV	80.35%	88.80%	55.28%
	N	6	5	6
SECONDARY :	AVG	59.51%	39.02%	68.72%
	ST DEV	37.57%	59.84%	53.81%
	N	6	6	6
INDIANA		19.80%	0.16%	70.51%
t-TEST P-VALUE		>0.10	>0.10	>0.10

SHORT-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	21.40%	45.49%	19.74%
	ST DEV	19.35%	56.77%	19.78%
	N	6	5	6
SECONDARY :	AVG	31.91%	53.67%	24.87%
	ST DEV	12.11%	22.66%	12.06%
	N	6	6	6
INDIANA		27.15%	25.32%	29.06%
t-TEST P-VALUE		>0.10	>0.10	>0.10

NOTE : A P-VALUE OF HIGHER THAN 0.10 INDICATES THAT THERE WAS NO SIGNIFICANT DIFFERENCE IN EMPLOYMENT GROWTH BETWEEN THE TWO GROUPS. A POSITIVE P-VALUE OF LESS THAN 0.10 INDICATES THAT THE FIRST GROUP HAD A SIGNIFICANTLY HIGHER EMPLOYMENT GROWTH THAN THE SECOND GROUP, AND A NEGATIVE VALUE THE OPPOSITE.
TOTAL, MANUF AND SERVICE INDICATE RESPECTIVELY DATA CONCERNING TOTAL, MANUFACTURING AND SERVICE EMPLOYMENT.

the state. None of the t-tests indicated a significant difference between mean increases in county employment.

Analysis of US-30

The location of the section of US-30 that were regarded for the purpose of this study, namely between Plymouth and I-69, are presented in Figure 5.12. The four-lane construction of this road took place in two continuous sections, namely 40 miles between 1959 and 1962 (Section 1), and 23 miles between 1968 and 1972 (Section 2).

US-30 Section 1

This section was located in three counties, namely Kosciusko, Whitley, and Allen Counties. Employment data were not available for 1960 and 1961, two of the construction years.

Figure 5.13 shows employment base and change data for the counties and time period involved in the construction of this section. The primary counties had a much higher employment base throughout the construction period, mainly because of the inclusion of Allen County, one of the most economically active counties in the state. Yearly employment changes per county group varied over the term, with state changes lagging the other two county group changes in most years. In both the short- and long-term analyses, primary and secondary county

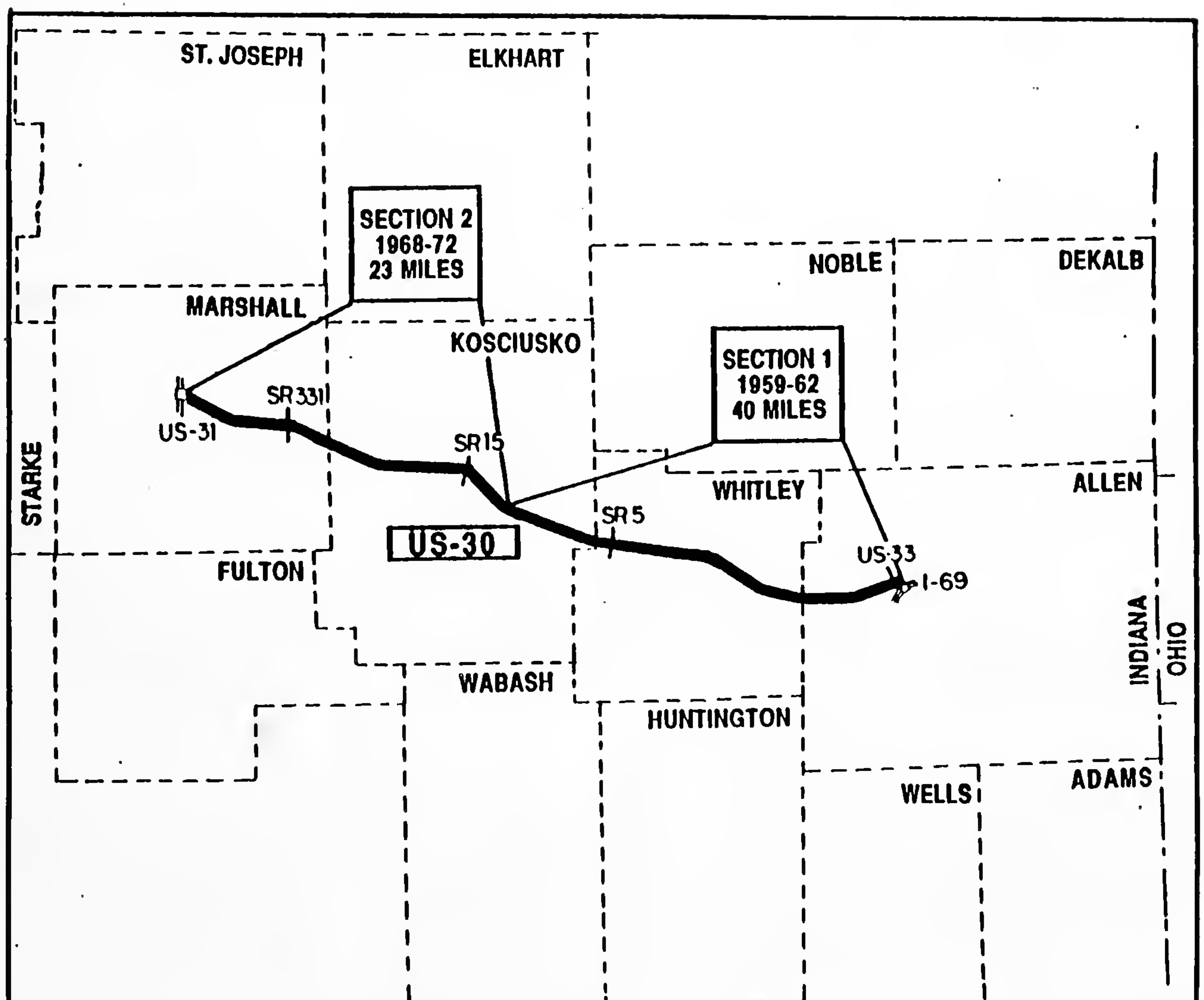


Figure 5.12 Primary and Secondary Counties: US-30

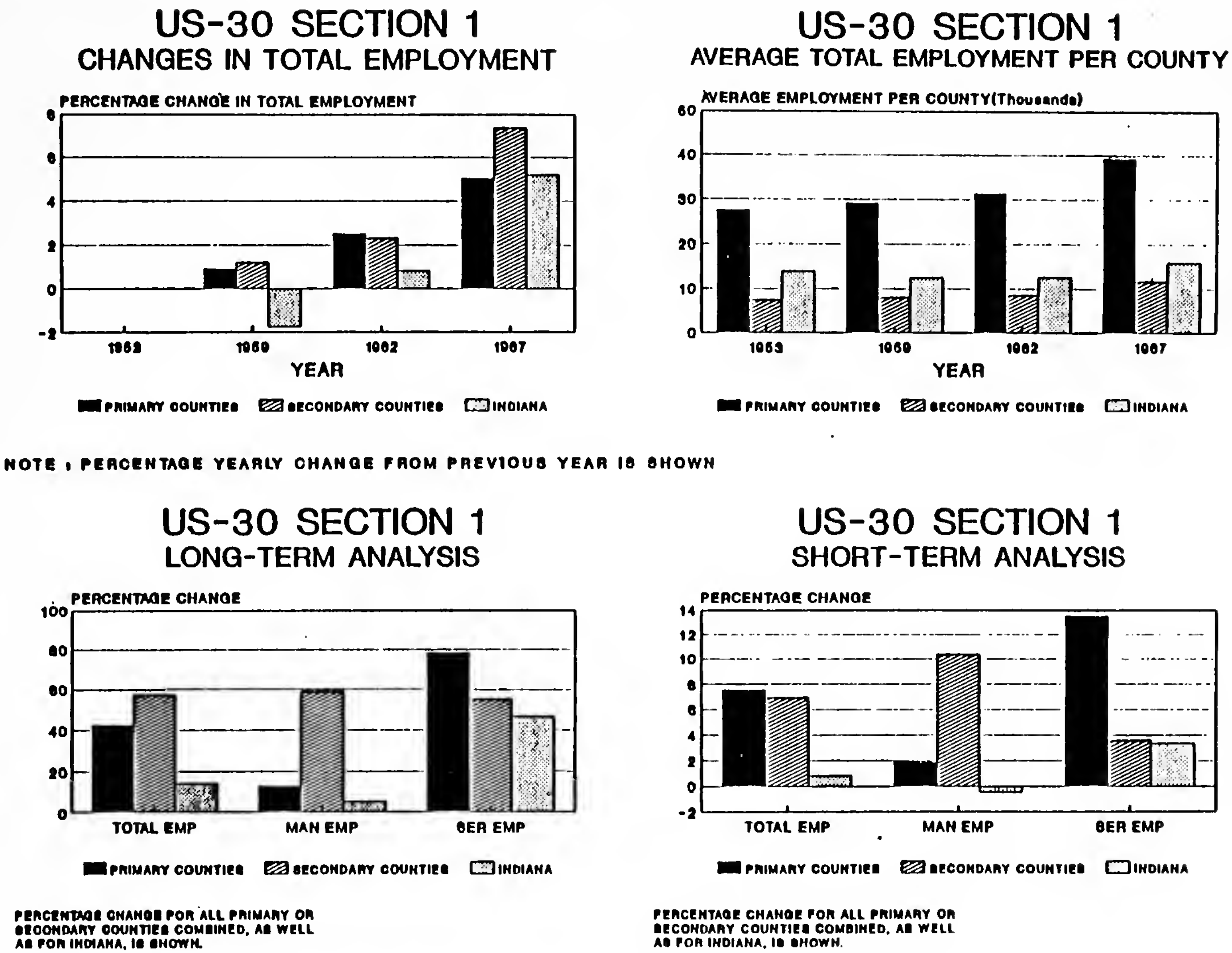


Figure 5.13 Annual, Long- and Short-Term Employment Changes and Annual Employment Base: US-30 Section 1

employment grew more than the state's employment in all sectors, and primary counties' manufacturing sector growth was less than secondary counties, while the opposite happened in the service sector.

Comparative data and results from the t-tests are given in Table 5.5. The average yearly employment change for primary and secondary counties were higher than for the state as a whole in all cases, with just service employment in primary counties being higher than in secondary counties. None of the t-tests did however indicate a statistically significant difference between any of the groups, in any industry sector. The short- and long-term analyses for individual counties indicated that none of the mean changes were significantly different, although over the long term both primary and secondary counties had a much higher employment increase than the state in almost all sectors.

US-30 Section 2

As seen in Figure 5.12, this section covered two counties namely Marshall and Kosciusko, over a distance of 23 miles, and was constructed under the "Killer Road Program" [INDOT 1972]. The employment data shown in Figure 5.14 indicate that the average county employment in primary counties was lower than that in the other two groups of counties, and the positive year-to-year changes for these counties were more

Table 5.5 Results from Comparative Data and t-Tests: US-30 Section 1

RESULTS OF COMPARATIVE t-TESTS : US-30 SECTION 1				
TESTS FOR YEARLY CHANGES PER COUNTY GROUP : POOLED DATA				
		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	2.83%	1.15%	4.62%
	ST DEV	2.08%	2.98%	0.89%
	N	3	3	3
SECONDARY :	AVG	3.63%	3.98%	3.22%
	ST DEV	3.29%	3.98%	2.40%
	N	3	3	3
INDIANA :	AVG	1.44%	0.78%	2.78%
	ST DEV	3.52%	4.02%	1.98%
	N	3	3	3
P-VALUES :				
PR VS SEC		>0.10	>0.10	>0.10
PR VS INDIANA		>0.10	>0.10	>0.10
SEC VS INDIANA		>0.10	>0.10	>0.10
TESTS FOR INDIVIDUAL COUNTIES IN A GROUP				
LONG-TERM ANALYSIS : INDIVIDUAL COUNTIES				
		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	71.96%	56.83%	61.97%
	ST DEV	62.56%	69.06%	28.43%
	N	3	3	3
SECONDARY :	AVG	53.31%	68.62%	42.61%
	ST DEV	18.43%	48.40%	21.94%
	N	9	9	9
INDIANA		13.89%	5.12%	46.38%
t-TEST P-VALUE		>0.10	>0.10	>0.10
SHORT-TERM ANALYSIS : INDIVIDUAL COUNTIES				
		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	-1.35%	-8.04%	8.54%
	ST DEV	20.37%	25.16%	12.55%
	N	3	3	3
SECONDARY :	AVG	8.24%	14.08%	3.79%
	ST DEV	8.69%	17.36%	3.56%
	N	9	9	9
INDIANA		0.83%	-0.46%	3.36%
t-TEST P-VALUE		>0.10	>0.10	>0.10

NOTE : A P-VALUE OF HIGHER THAN 0.10 INDICATES THAT THERE WAS NO SIGNIFICANT DIFFERENCE IN EMPLOYMENT GROWTH BETWEEN THE TWO GROUPS. A POSITIVE P-VALUE OF LESS THAN 0.10 INDICATES THAT THE FIRST GROUP HAD A SIGNIFICANTLY HIGHER EMPLOYMENT GROWTH THAN THE SECOND GROUP, AND A NEGATIVE VALUE THE OPPOSITE.
TOTAL, MANUF AND SERVICE INDICATE RESPECTIVELY DATA CONCERNING TOTAL, MANUFACTURING AND SERVICE EMPLOYMENT.

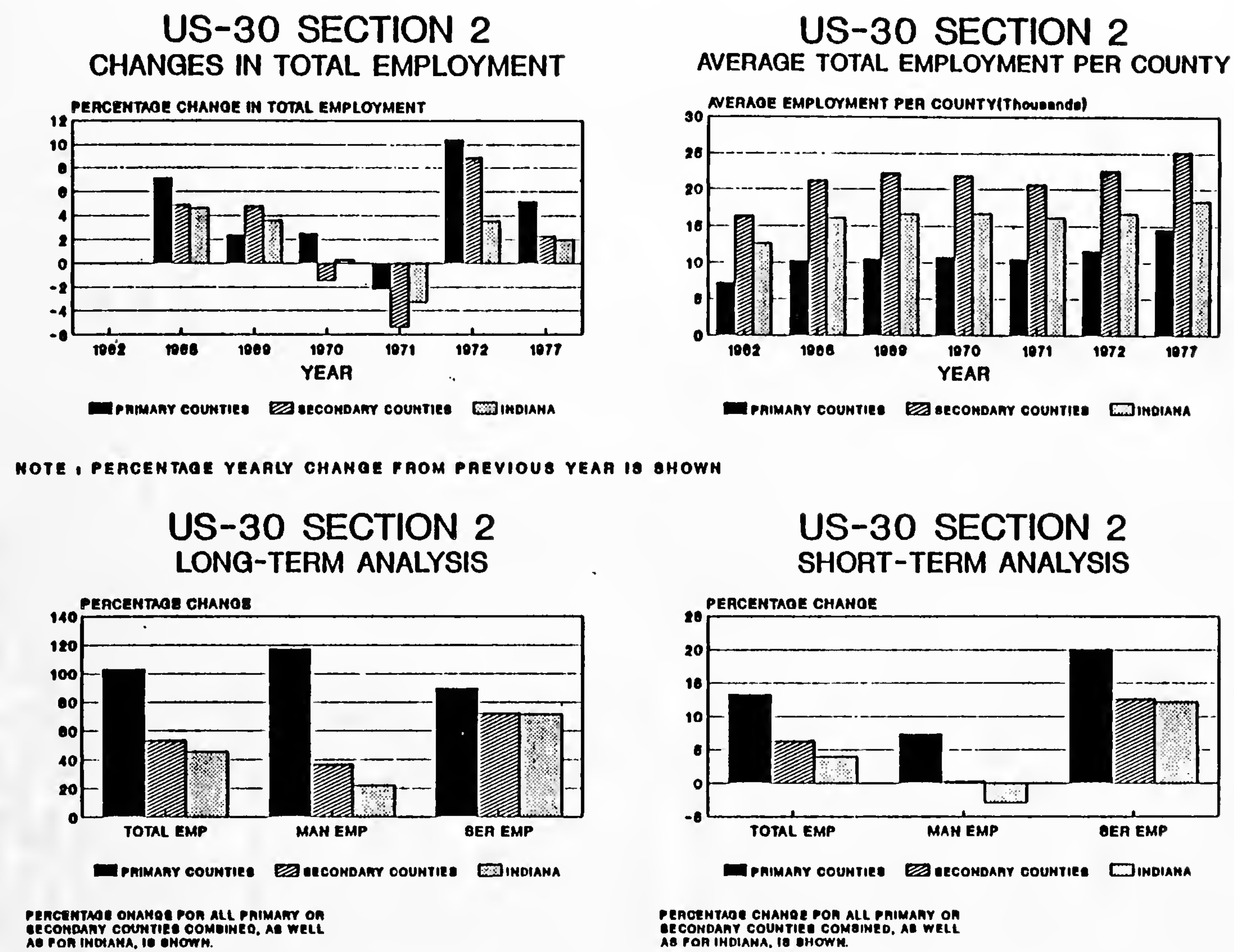


Figure 5.14 Annual, Long- and Short-Term Employment Changes and Annual Employment Base: US-30 Section 2

than in the other groups in most cases. Over both the long and the short term did primary and secondary counties lead the state in employment growth in all industry sectors, and primary employment had a higher percentage increase than secondary counties.

Although the t-tests for annual changes were not significant in any of the pooled data groups, as presented in Table 5.6, the trend of primary counties surpassing secondary counties and both groups leading the state in all three sectors were continued. This held also true for the individual county analyses in the long term, where primary counties had statistically a significantly higher mean employment increase than secondary counties in the total industry and manufacturing sectors. Although no other t-tests indicated any significant differences, primary counties led secondary counties in most other cases. Also, these two groups again had higher increases than the state.

Analysis of US-31

Figure 5.15 shows the section of US-31 that were examined for this study, namely from the intersection with US-30 to the city of Kokomo. Construction took place in two distinct periods, namely a 10-mile section in 1963 to 1964 and located in Miami County (Section 1), and a 48-mile section in Marshall, Fulton, Miami, and Howard Counties (Section 2).

Table 5.6 Results from Comparative Data and t-Tests: US-30 Section 2

RESULTS OF COMPARATIVE t-TESTS : US-30 SECTION 2

TESTS FOR YEARLY CHANGES PER COUNTY GROUP : POOLED DATA

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	4.22%	3.84%	4.72%
	ST DEV	4.37%	5.70%	3.28%
	N	6	6	6
SECONDARY :	AVG	2.33%	1.26%	3.45%
	ST DEV	5.07%	7.27%	3.11%
	N	6	6	6
INDIANA :	AVG	1.77%	0.28%	3.37%
	ST DEV	2.91%	3.91%	1.89%
	N	6	6	6
P-VALUES :				
PR VS SEC		>0.10	>0.10	>0.10
PR VS INDIANA		>0.10	>0.10	>0.10
SEC VS INDIANA		>0.10	>0.10	>0.10

TESTS FOR INDIVIDUAL COUNTIES IN A GROUP

LONG-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	103.89%	120.20%	88.68%
	ST DEV	3.21%	11.30%	7.11%
	N	2	2	2
SECONDARY :	AVG	65.55%	61.09%	76.29%
	ST DEV	27.01%	41.53%	27.70%
	N	8	8	8
INDIANA		45.63%	22.21%	71.64%
t-TEST P-VALUE		0.047	0.047	>0.10

SHORT-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	12.97%	6.60%	19.84%
	ST DEV	1.55%	3.25%	1.33%
	N	2	2	2
SECONDARY :	AVG	12.18%	9.02%	18.00%
	ST DEV	11.63%	20.22%	6.51%
	N	8	8	8
INDIANA		3.96%	-2.88%	12.13%
t-TEST P-VALUE		>0.10	>0.10	>0.10

NOTE : A P-VALUE OF HIGHER THAN 0.10 INDICATES THAT THERE WAS NO SIGNIFICANT DIFFERENCE IN EMPLOYMENT GROWTH BETWEEN THE TWO GROUPS. A POSITIVE P-VALUE OF LESS THAN 0.10 INDICATES THAT THE FIRST GROUP HAD A SIGNIFICANTLY HIGHER EMPLOYMENT GROWTH THAN THE SECOND GROUP, AND A NEGATIVE VALUE THE OPPOSITE.
TOTAL, MANUF AND SERVICE INDICATE RESPECTIVELY DATA CONCERNING TOTAL, MANUFACTURING AND SERVICE EMPLOYMENT.

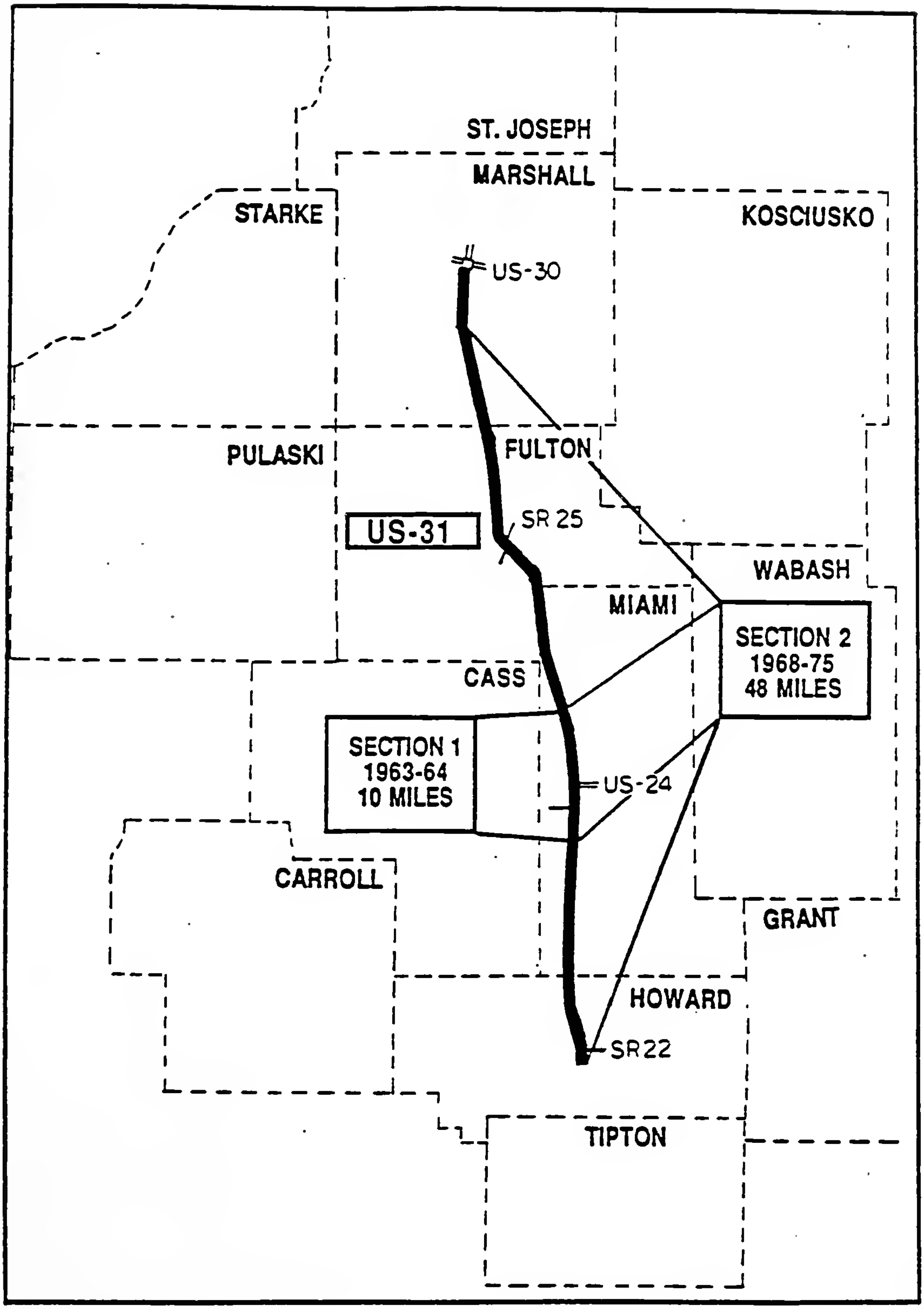


Figure 5.15 Primary and Secondary Counties: US-31

US-31 Section 1

The only primary county in this section was Miami County. Data was available only for 1964, and therefore no short-term analysis was performed for this section. Figure 5.16 presents the employment data associated with the counties that were investigated. Miami County's employment base was lower than the other two groups' for the duration of the project, as well as before and after. The change in employment per year in primary counties also lagged secondary counties throughout the time period, while the state's average varied relatively. A similar trend was observed in the long-term changes in employment in the three economic sectors and county groups.

From the results of the t-tests for annual changes in employment as shown in Table 5.7, it was evident that there was no statistically different employment changes between primary and secondary counties, except in the service sector where secondary counties had a significantly higher change than primary counties. In the individual county analysis, it was found that the mean employment increase over the long term in primary counties was not significantly different from secondary counties, although primary counties lagged in all three sectors.

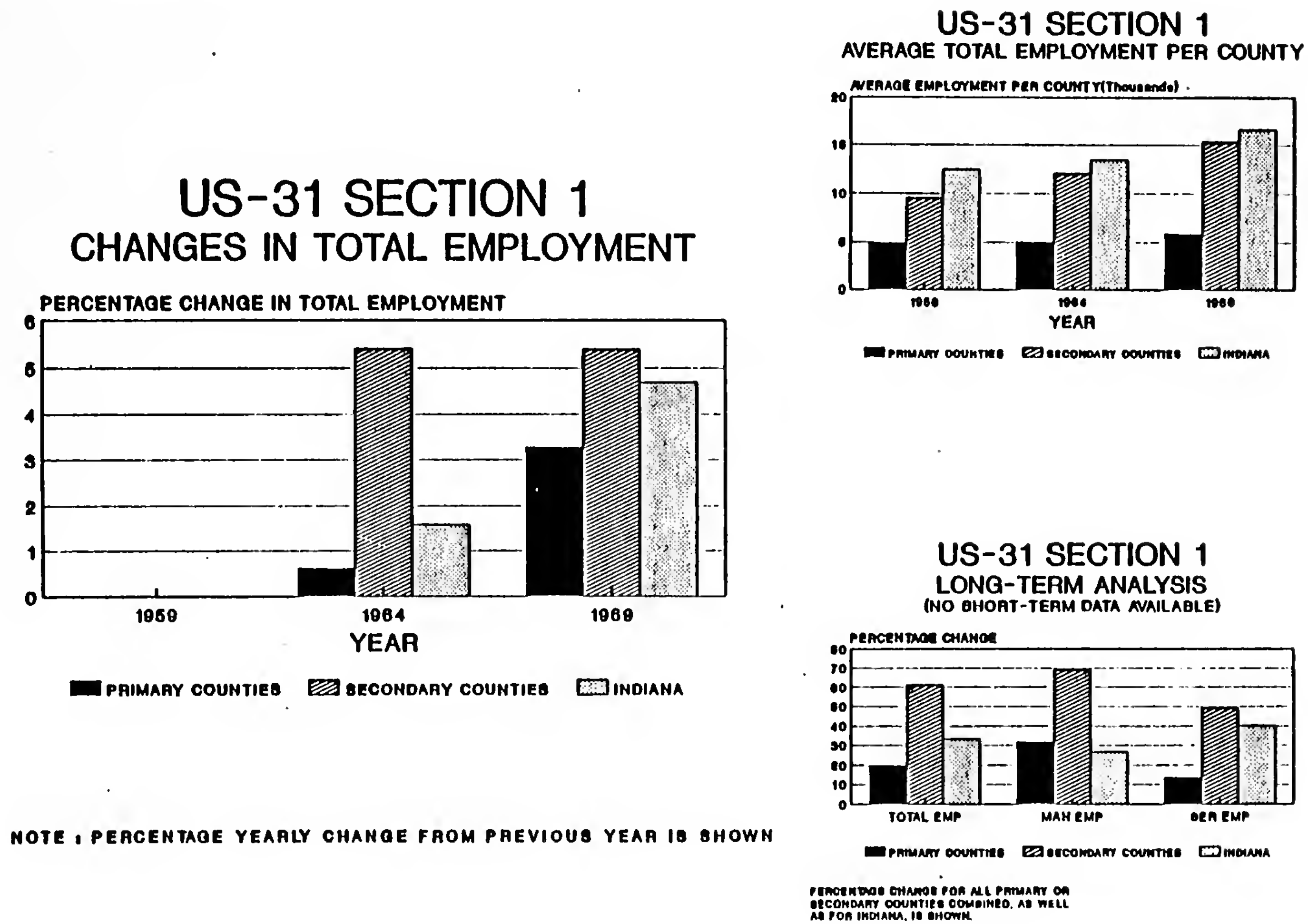


Figure 5.16 Annual, Long- and Short-Term Employment Changes and Annual Employment Base: US-31 Section 1

Table 5.7 Results from Comparative Data and t-Tests: US-31 Section 1

RESULTS OF COMPARATIVE t-TESTS : US-31 SECTION 1

TESTS FOR YEARLY CHANGES PER COUNTY GROUP : POOLED DATA

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	1.95%	2.99%	1.37%
	ST DEV	1.88%	1.64%	1.42%
	N	2	2	2
SECONDARY :	AVG	5.40%	6.01%	4.42%
	ST DEV	0.01%	0.30%	0.13%
	N	2	2	2
INDIANA :	AVG	3.14%	2.55%	3.71%
	ST DEV	2.20%	2.09%	1.97%
	N	2	2	2
P-VALUES :				
PR VS SEC		>0.10	>0.10	0.048(-)
PR VS INDIANA		>0.10	>0.10	>0.10
SEC VS INDIANA		>0.10	>0.10	>0.10

TESTS FOR INDIVIDUAL COUNTIES IN A GROUP

LONG-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	19.96%	31.78%	13.89%
	ST DEV	0.00%	0.00%	0.00%
	N	1	1	1
SECONDARY :	AVG	55.57%	75.30%	40.10%
	ST DEV	14.14%	20.89%	26.16%
	N	4	4	4
INDIANA		33.25%	26.56%	40.09%
t-TEST P-VALUE		>0.10	>0.10	>0.10

SHORT-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	N/A	N/A	N/A
	ST DEV	N/A	N/A	N/A
	N	N/A	N/A	N/A
SECONDARY :	AVG	N/A	N/A	N/A
	ST DEV	N/A	N/A	N/A
	N	N/A	N/A	N/A
INDIANA		N/A	N/A	N/A
t-TEST P-VALUE		N/A	N/A	N/A

NOTE : A P-VALUE OF HIGHER THAN 0.10 INDICATES THAT THERE WAS NO SIGNIFICANT DIFFERENCE IN EMPLOYMENT GROWTH BETWEEN THE TWO GROUPS. A POSITIVE P-VALUE OF LESS THAN 0.10 INDICATES THAT THE FIRST GROUP HAD A SIGNIFICANTLY HIGHER EMPLOYMENT GROWTH THAN THE SECOND GROUP, AND A NEGATIVE VALUE THE OPPOSITE.
TOTAL, MANUF AND SERVICE INDICATE RESPECTIVELY DATA CONCERNING TOTAL, MANUFACTURING AND SERVICE EMPLOYMENT.

US-31 Section 2

This section of 48 miles was built into four lanes from 1968 to 1975 in four counties, mostly under the "Killer Road Program" [INDOT 1972]. Figure 5.17 presents the pooled employment data for this segment, and indicates that the primary counties had a slightly smaller employment base than secondary counties or the average county in the state. In most years, the primary county annual change in total employment was higher than both of the other groups, except towards the end of the time period. Over both the long and short term did primary counties display a higher increase in employment growth than secondary counties, in almost all sectors. Relative state-wide changes varied, but were usually less than primary county changes.

The average annual employment change in primary counties was the highest of the three groups in all sectors as shown in Table 5.8, although none of the t-tests indicates a significant difference between any of the county groups, in any of the employment categories. Also, over the long and the short term primary counties' changes dominated over secondary county changes in almost all categories, and these two groups dominated the state changes during both time-periods and in virtually all sectors. None of the differences were statistically significant.

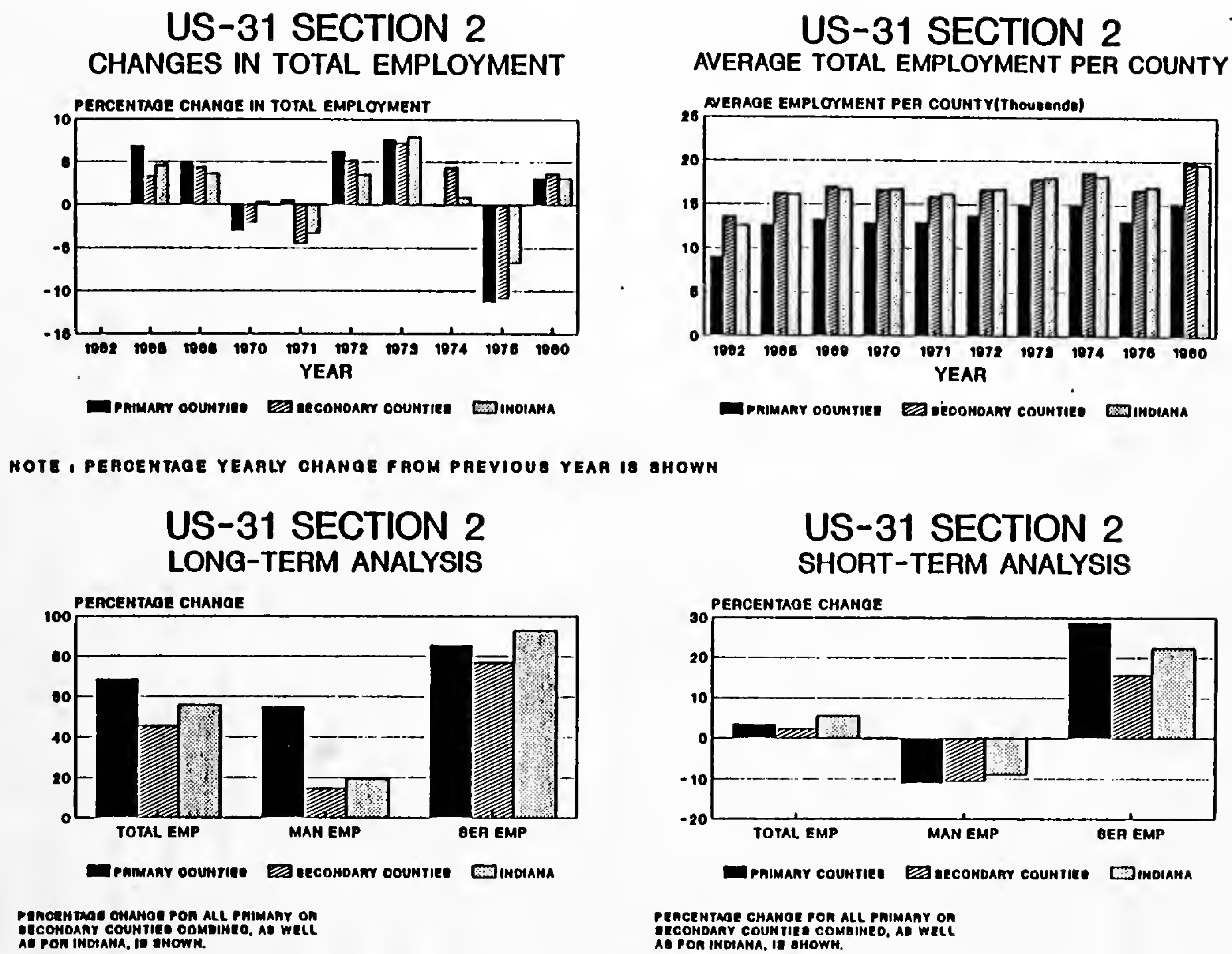


Figure 5.17 Annual, Long- and Short-Term Employment Changes and Annual Employment Base: US-31 Section 2

Table 5.8 Results from Comparative Data and t-Tests: US-31 Section 2

RESULTS OF COMPARATIVE t-TESTS : US-31 SECTION 2

TESTS FOR YEARLY CHANGES PER COUNTY GROUP : POOLED DATA

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	1.63%	0.28%	3.71%
	ST DEV	6.01%	8.67%	3.42%
	N	9	9	9
SECONDARY :	AVG	1.20%	-0.47%	2.72%
	ST DEV	5.83%	7.06%	5.38%
	N	9	9	9
INDIANA :	AVG	1.54%	-0.30%	3.33%
	ST DEV	4.40%	6.03%	2.41%
	N	9	9	9
P-VALUES :				
PR VS SEC		>0.10	>0.10	>0.10
PR VS INDIANA		>0.10	>0.10	>0.10
SEC VS INDIANA		>0.10	>0.10	>0.10

TESTS FOR INDIVIDUAL COUNTIES IN A GROUP

LONG-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	76.32%	82.29%	74.13%
	ST DEV	33.37%	54.88%	28.48%
	N	4	4	4
SECONDARY :	AVG	63.03%	49.22%	81.46%
	ST DEV	32.06%	47.23%	26.08%
	N	9	9	9
INDIANA		55.59%	19.36%	92.79%
t-TEST P-VALUE		>0.10	>0.10	>0.10

SHORT-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	12.05%	5.38%	26.05%
	ST DEV	10.36%	17.11%	6.13%
	N	4	4	4
SECONDARY :	AVG	9.51%	1.42%	19.99%
	ST DEV	13.21%	18.26%	8.03%
	N	9	9	9
INDIANA		5.58%	-8.82%	22.41%
t-TEST P-VALUE		>0.10	>0.10	>0.10

NOTE : A P-VALUE OF HIGHER THAN 0.10 INDICATES THAT THERE WAS NO SIGNIFICANT DIFFERENCE IN EMPLOYMENT GROWTH BETWEEN THE TWO GROUPS. A POSITIVE P-VALUE OF LESS THAN 0.10 INDICATES THAT THE FIRST GROUP HAD A SIGNIFICANTLY HIGHER EMPLOYMENT GROWTH THAN THE SECOND GROUP, AND A NEGATIVE VALUE THE OPPOSITE.
TOTAL, MANUF AND SERVICE INDICATE RESPECTIVELY DATA CONCERNING TOTAL, MANUFACTURING AND SERVICE EMPLOYMENT.

Analysis of US-41 North

This relatively short section of highway, located between SR 63 and US-52, was constructed from 1973 to 1976 in Benton and Warren Counties, and is shown in Figure 5.18. Due to inadequate data for Warren County, only Benton County was considered in this analysis. Employment data concerning the pre- to post-construction period are presented in Figure 5.19, and shows that the two primary counties had a much lower employment base than secondary or state average counties. The annual change in employment also lagged these two types of counties for most years in the study period. From the long and short term graphical analysis it is evident that this trend continued, although manufacturing and service employment showed varying changes over the two time periods.

In Table 5.9, comparative data and results from the t-tests for this section are given. Primary and secondary counties had higher average annual changes in employment than the state, although none of these were significantly different between any of the groups.

In the long- and short-term analysis of individual counties, secondary counties had a higher percentage increase in employment than primary counties and the state in all sectors, except for the service industry mean increase that was higher in primary counties than in secondary counties over the

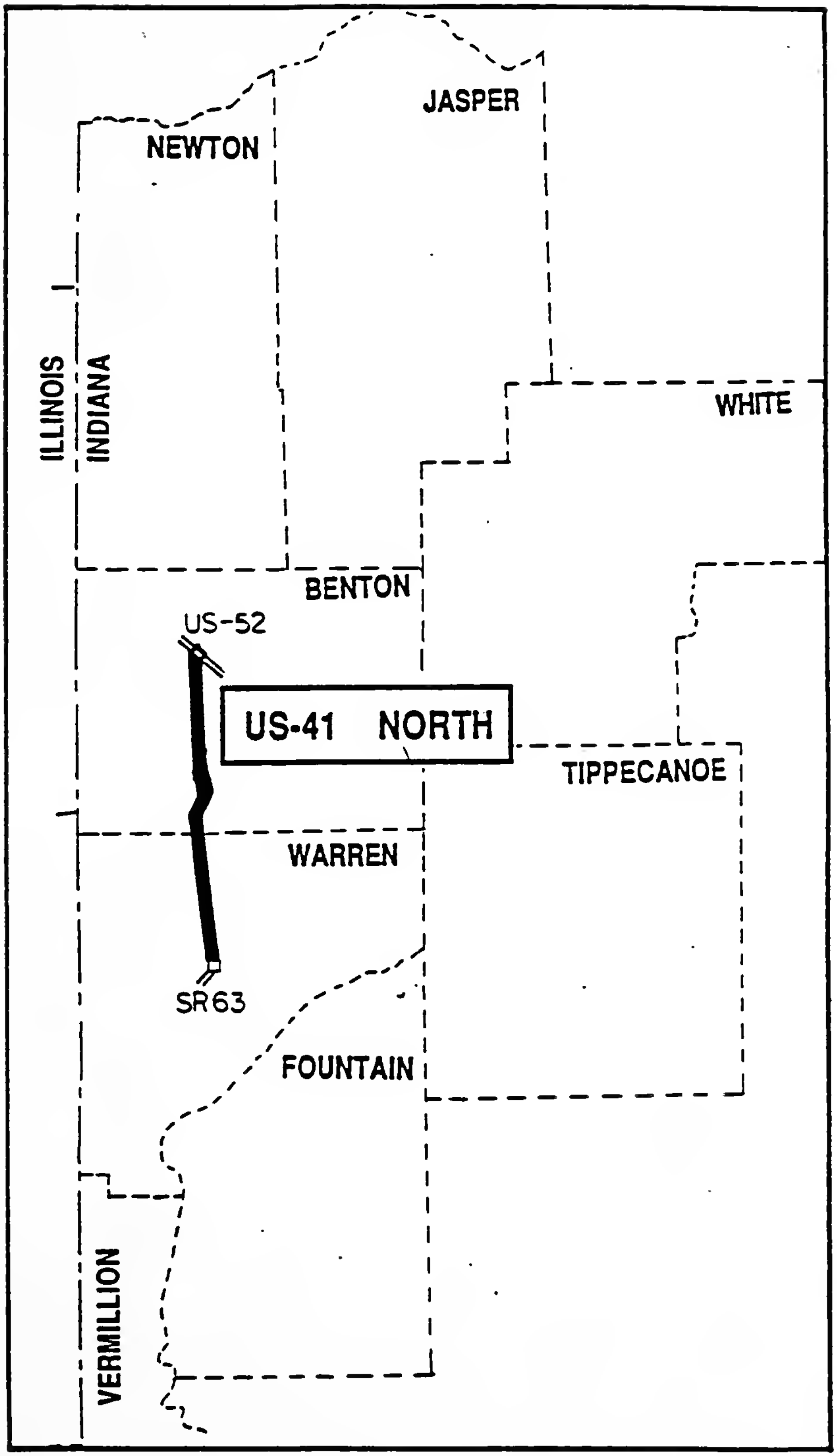


Figure 5.18 Primary and Secondary Counties: US-41 North

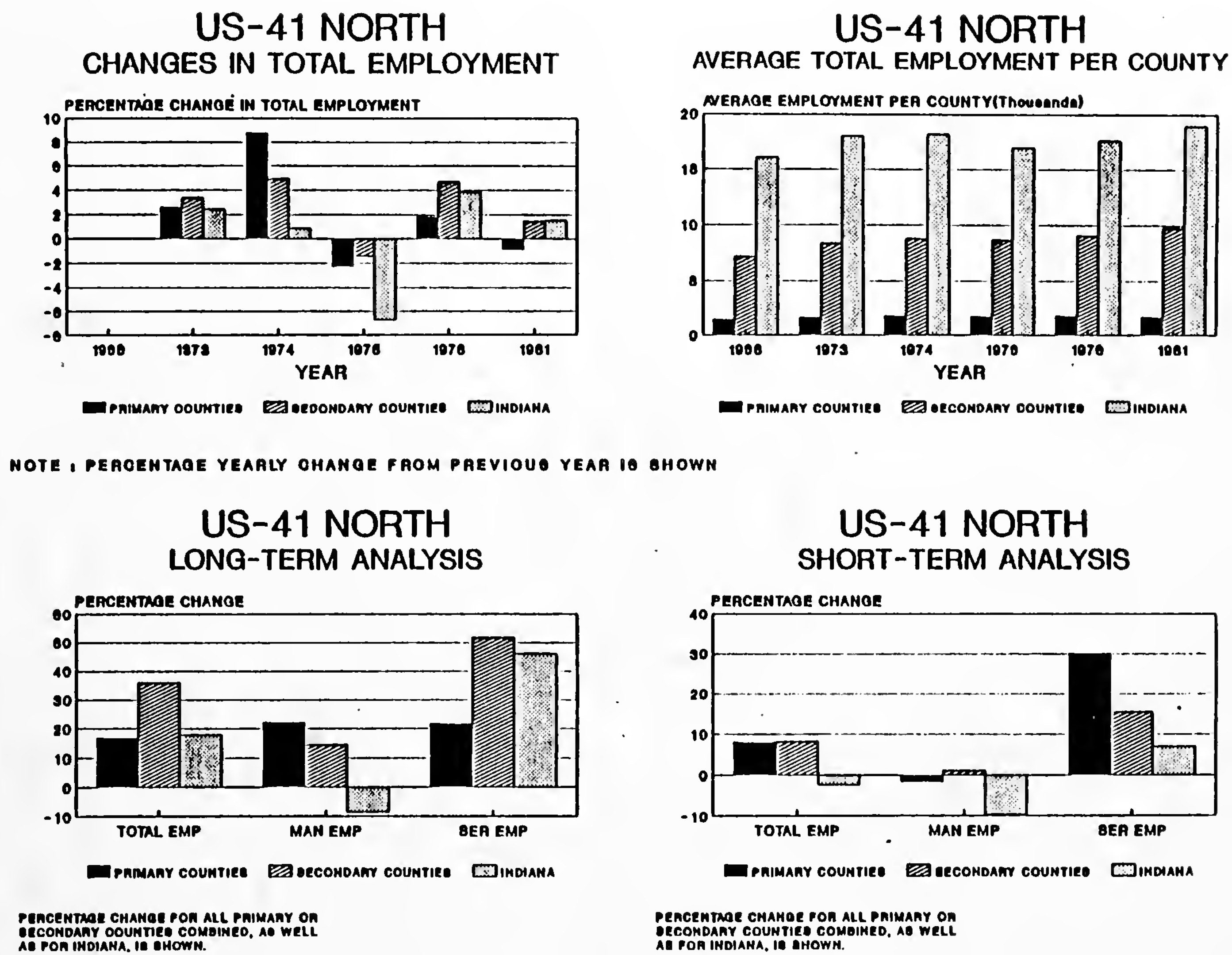


Figure 5.19 Annual, Long- and Short-Term Employment Changes and Annual Employment Base: US-41 North

Table 5.9 Results from Comparative Data and t-Tests: US-41 North

RESULTS OF COMPARATIVE t-TESTS : US-41 NORTH

TESTS FOR YEARLY CHANGES PER COUNTY GROUP : POOLED DATA

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	2.00%	3.91%	5.64%
	ST DEV	4.29%	29.11%	12.02%
	N	5	5	5
SECONDARY :	AVG	2.61%	0.80%	4.20%
	ST DEV	2.65%	2.10%	4.02%
	N	5	5	5
INDIANA :	AVG	0.39%	-1.77%	2.76%
	ST DEV	4.13%	6.16%	2.13%
	N	5	5	5
P-VALUES :				
PR VS SEC		>0.10	>0.10	>0.10
PR VS INDIANA		>0.10	>0.10	>0.10
SEC VS INDIANA		>0.10	>0.10	>0.10

TESTS FOR INDIVIDUAL COUNTIES IN A GROUP

LONG-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	16.85%	22.33%	21.75%
	ST DEV	0.00%	0.00%	0.00%
	N	1	1	1
SECONDARY :	AVG	49.13%	46.64%	52.66%
	ST DEV	32.00%	63.00%	23.25%
	N	6	6	6
INDIANA		17.96%	-8.38%	46.17%
t-TEST P-VALUE		>0.10	>0.10	>0.10

SHORT-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	8.19%	-1.59%	30.12%
	ST DEV	0.00%	0.00%	0.00%
	N	1	1	1
SECONDARY :	AVG	21.75%	48.42%	15.88%
	ST DEV	26.40%	96.22%	6.99%
	N	6	6	6
INDIANA		-2.31%	-9.56%	7.13%
t-TEST P-VALUE		>0.10	>0.10	>0.10

NOTE : A P-VALUE OF HIGHER THAN 0.10 INDICATES THAT THERE WAS NO SIGNIFICANT DIFFERENCE IN EMPLOYMENT GROWTH BETWEEN THE TWO GROUPS. A POSITIVE P-VALUE OF LESS THAN 0.10 INDICATES THAT THE FIRST GROUP HAD A SIGNIFICANTLY HIGHER EMPLOYMENT GROWTH THAN THE SECOND GROUP, AND A NEGATIVE VALUE THE OPPOSITE.
TOTAL, MANUF AND SERVICE INDICATE RESPECTIVELY DATA CONCERNING TOTAL, MANUFACTURING AND SERVICE EMPLOYMENT.

construction period. No mean changes were statistically significantly different in any groups or sectors.

Analysis of US-41 South

This section of US-41, as shown in Figure 5.20, was divided into two separate sections for analysis purposes, namely a shorter northern section of 12 miles (Section 1), and a southern 40 mile section (Section 2).

US-41 South, Section 1

This section of twelve miles long was constructed into four lanes between 1950 and 1955, and was contained in only one primary county, namely Vigo County. This was economically a relatively active county with an employment base larger than the average Indiana county, and much larger than the average secondary counties, as shown in Figure 5.21. Due to the fact that no data were available before 1950, only a short-term analysis was performed. Also, no data could be procured for 1952, 1954 and 1955, and these years were omitted from the analysis. In 1950 only manufacturing industry employment figures were obtainable, and the analyses for all three sectors were performed from 1951 to 1956. These limited data could affect results and interpretations.

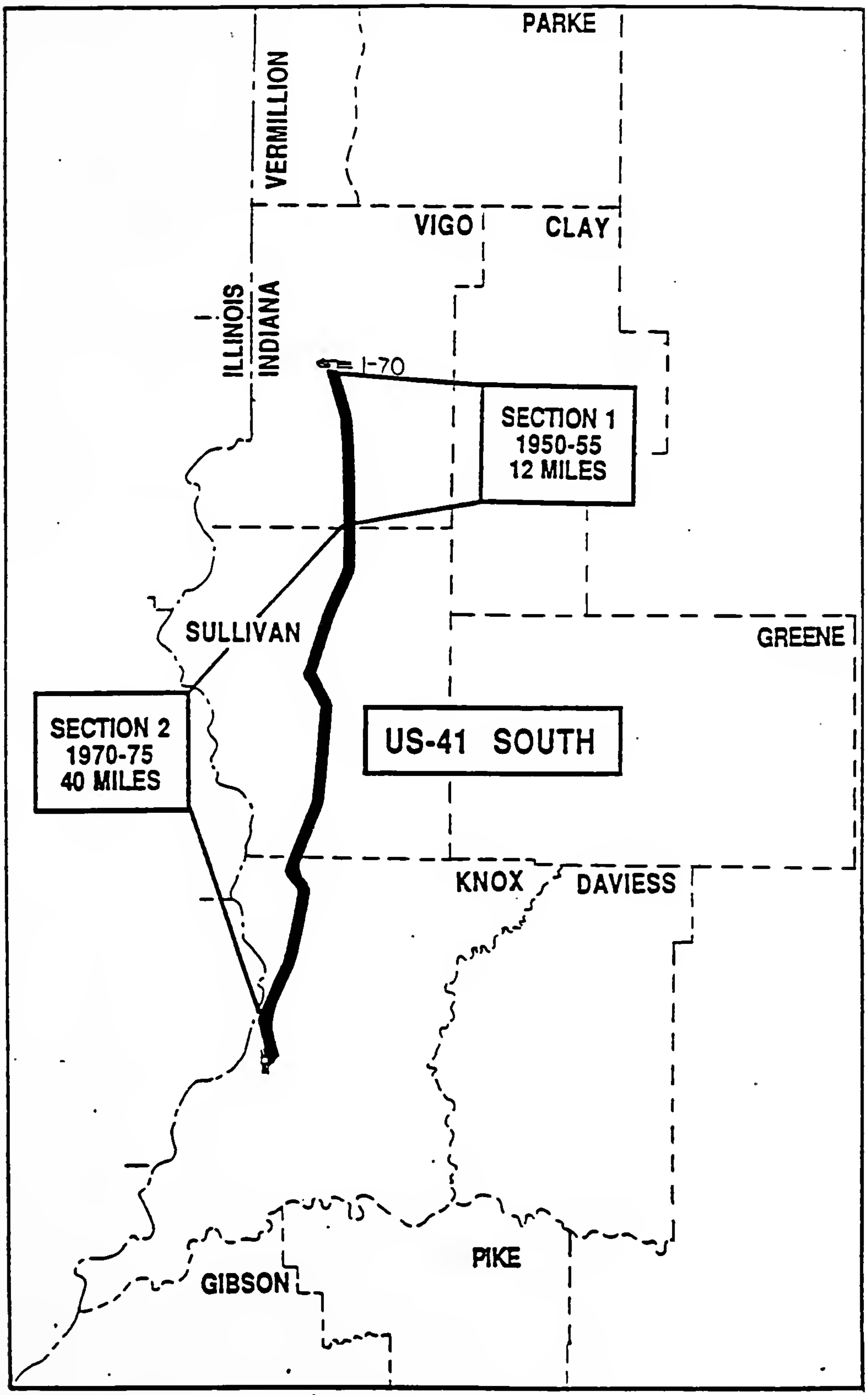
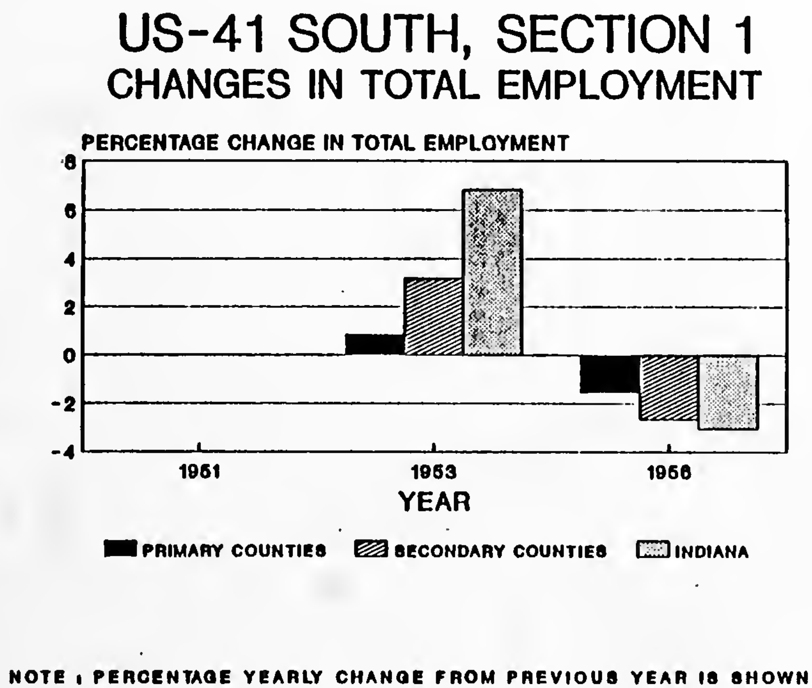
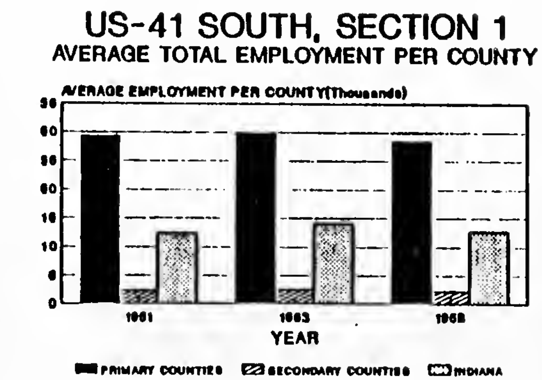


Figure 5.20 Primary and Secondary Counties: US-41 South





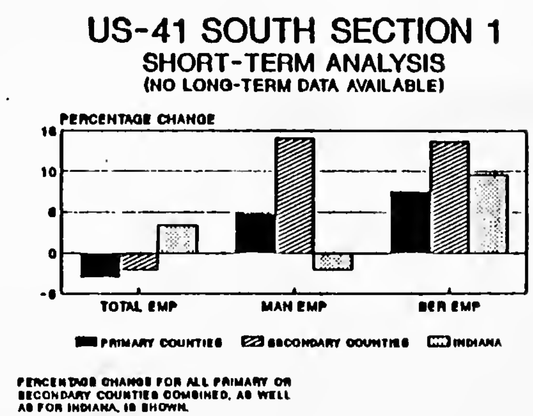


Figure 5.21 Annual, Long- and Short-Term Employment Changes and Annual Employment Base: US-41 South Section 1

Also from Figure 5.21, it is evident that the pooled county changes from year to year varied over the same time period, and primary counties lagged secondary counties and in some cases the state in employment growth over the short term in all sectors. Table 5.10 indicates that primary counties seemed to lag the state in year-to-year employment changes in most cases, while primary counties lagged the state and secondary counties in average total employment change per county over the short term. No statistically significant differences existed between county groups in either the annual change data or in the short-term individual county data.

US-41 South, Section 2

As was seen in Figure 5.20, this section of US-41 consisted of 40 miles of four-lane highway, and was constructed from 1970 to 1975 in Sullivan and Knox Counties. A part of this highway was constructed under the "Killer Road Program" [INDOT 1972]. The two primary counties had a slightly smaller average employment base than the four secondary counties, as shown in Figure 5.22. The annual changes over the period from 1965 to 1980 varied largely relative to primary and secondary counties, not indicating a specific pattern of annual change. Over both the long and short term primary counties trailed secondary counties as well as the average state county in all economic sectors.

Table 5.10 Results from Comparative Data and t-Tests: US-41 South Section 1

RESULTS OF COMPARATIVE t-TESTS : US-41 SOUTH SECTION 1

TESTS FOR YEARLY CHANGES PER COUNTY GROUP : POOLED DATA

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	0.12%	-0.33%	3.21%
	ST DEV	1.46%	5.84%	2.84%
	N	3	3	3
SECONDARY :	AVG	-0.82%	2.32%	1.29%
	ST DEV	3.47%	14.71%	2.75%
	N	3	3	3
INDIANA :	AVG	2.35%	-0.15%	2.08%
	ST DEV	5.00%	4.67%	0.36%
	N	3	3	3
P-VALUES :				
PR VS SEC		>0.10	>0.10	>0.10
PR VS INDIANA		>0.10	>0.10	>0.10
SEC VS INDIANA		>0.10	>0.10	>0.10

TESTS FOR INDIVIDUAL COUNTIES IN A GROUP

LONG-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	N/A	N/A	N/A
	ST DEV	N/A	N/A	N/A
	N	N/A	N/A	N/A
SECONDARY :	AVG	N/A	N/A	N/A
	ST DEV	N/A	N/A	N/A
	N	N/A	N/A	N/A
INDIANA		N/A	N/A	N/A
t-TEST P-VALUE		N/A	N/A	N/A

SHORT-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	-3.05%	4.72%	7.47%
	ST DEV	0.00%	0.00%	0.00%
	N	1	1	1
SECONDARY :	AVG	0.63%	22.68%	14.68%
	ST DEV	15.31%	30.64%	14.67%
	N	4	4	4
INDIANA		3.34%	-2.11%	9.54%
t-TEST P-VALUE		>0.10	>0.10	>0.10

NO LONG-TERM ANALYSIS WAS DONE DUE TO DATA AVAILABILITY
A P-VALUE OF HIGHER THAN 0.10 INDICATES THAT THERE WAS NO SIGNIFICANT DIFFERENCE IN EMPLOYMENT GROWTH BETWEEN THE TWO GROUPS. A POSITIVE P-VALUE OF LESS THAN 0.10 INDICATES THAT THE FIRST GROUP HAD A SIGNIFICANTLY HIGHER EMPLOYMENT GROWTH THAN THE SECOND GROUP, AND A NEGATIVE VALUE THE OPPOSITE.
TOTAL, MANUF AND SERVICE INDICATE RESPECTIVELY DATA CONCERNING TOTAL, MANUFACTURING AND SERVICE EMPLOYMENT.

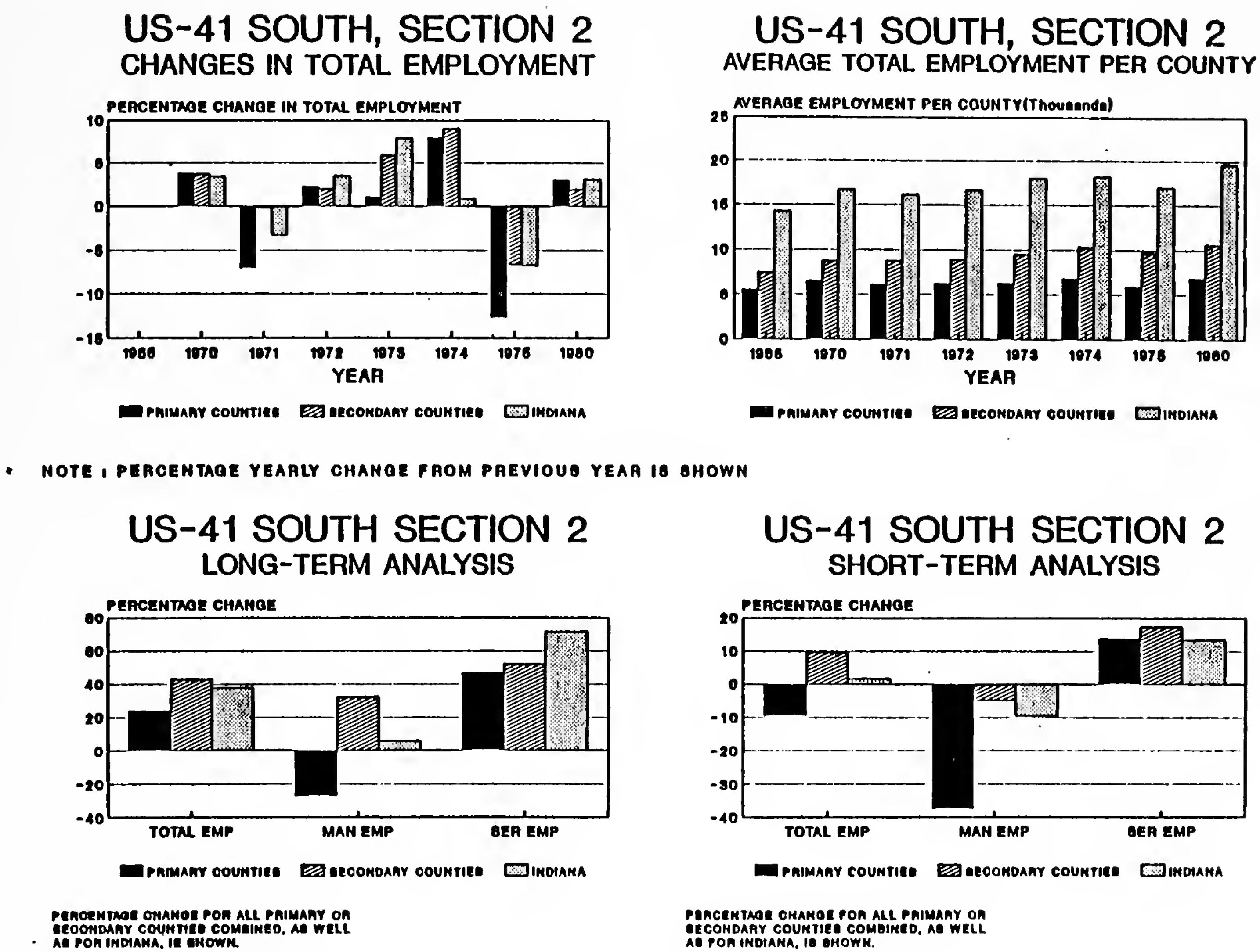


Figure 5.22 Annual, Long- and Short-Term Employment Changes and Annual Employment Base: US-41 South Section 2

Comparative data and t-test results, as presented in Table 5.11, indicated that primary counties trailed the other two groups in all sectors as far as average changes are concerned. The t-tests for difference in annual employment changes in the three county groups did however not indicate any significant differences. Over the long term secondary counties had a statistically significant higher change in total employment than primary counties, a trend that was continued but not significant in a statistical sense, over the short term.

Analysis of SR 37

Figure 5.23 indicates the location of SR 37 between US-50 at Bedford, and the Johnson-Marion County lines. Four primary counties were included in the analysis, as evident from the figure. This highway, that was part of the old Dixie Highway, was mainly constructed under the "Killer Road Program" [INDOT 1972]. Figure 5.24 indicates that primary counties had a smaller average employment base than the state's average county, but higher than the average of the ten secondary counties. In most years of the analysis, the primary counties leaded secondary and state counties in employment changes. This was also true for the long- and short-term changes, in almost all economic sectors.

Table 5.12 shows that the average annual primary and secondary change was numerically higher than the state in all cases, and

Table 5.11 Results from Comparative Data and t-Tests: US-41 South Section 2

RESULTS OF COMPARATIVE t-TESTS : US-41 SOUTH SECTION 2

TESTS FOR YEARLY CHANGES PER COUNTY GROUP : POOLED DATA

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	-0.24%	-5.06%	2.75%
	ST DEV	7.12%	14.62%	4.71%
	N	7	7	7
SECONDARY :	AVG	2.27%	0.51%	3.28%
	ST DEV	4.97%	7.10%	6.10%
	N	7	7	7
INDIANA :	AVG	1.26%	-0.76%	3.17%
	ST DEV	4.87%	6.63%	2.73%
	N	7	7	7
P-VALUES :				
PR VS SEC		>0.10	>0.10	>0.10
PR VS INDIANA		>0.10	>0.10	>0.10
SEC VS INDIANA		>0.10	>0.10	>0.10

TESTS FOR INDIVIDUAL COUNTIES IN A GROUP

LONG-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	25.23%	-12.08%	42.72%
	ST DEV	3.53%	29.81%	10.36%
	N	2	2	2
SECONDARY :	AVG	45.38%	15.04%	68.37%
	ST DEV	13.35%	26.25%	18.91%
	N	6	5	6
INDIANA		37.49%	5.89%	71.73%
t-TEST P-VALUE		0.047(-)	>0.10	>0.10

SHORT-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	-12.58%	-36.19%	15.95%
	ST DEV	8.84%	3.40%	4.58%
	N	2	2	2
SECONDARY :	AVG	17.91%	27.03%	18.13%
	ST DEV	29.07%	92.97%	10.52%
	N	6	6	6
INDIANA		1.66%	-9.47%	13.48%
t-TEST P-VALUE		>0.10	>0.10	>0.10

NOTE : A P-VALUE OF HIGHER THAN 0.10 INDICATES THAT THERE WAS NO SIGNIFICANT DIFFERENCE IN EMPLOYMENT GROWTH BETWEEN THE TWO GROUPS. A POSITIVE P-VALUE OF LESS THAN 0.10 INDICATES THAT THE FIRST GROUP HAD A SIGNIFICANTLY HIGHER EMPLOYMENT GROWTH THAN THE SECOND GROUP, AND A NEGATIVE VALUE THE OPPOSITE.
TOTAL, MANUF AND SERVICE INDICATE RESPECTIVELY DATA CONCERNING TOTAL, MANUFACTURING AND SERVICE EMPLOYMENT.

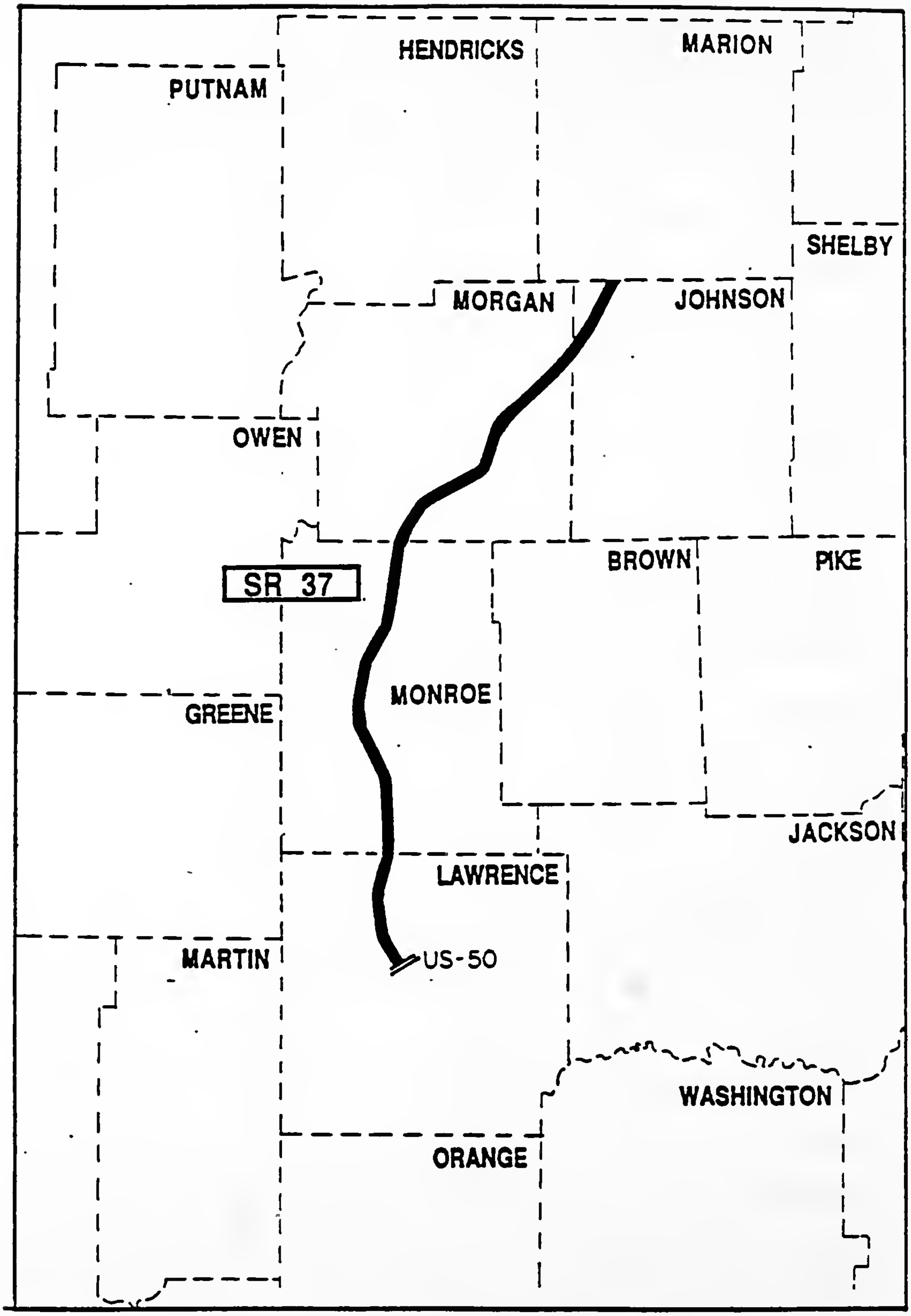


Figure 5.23 Primary and Secondary Counties: SR 37

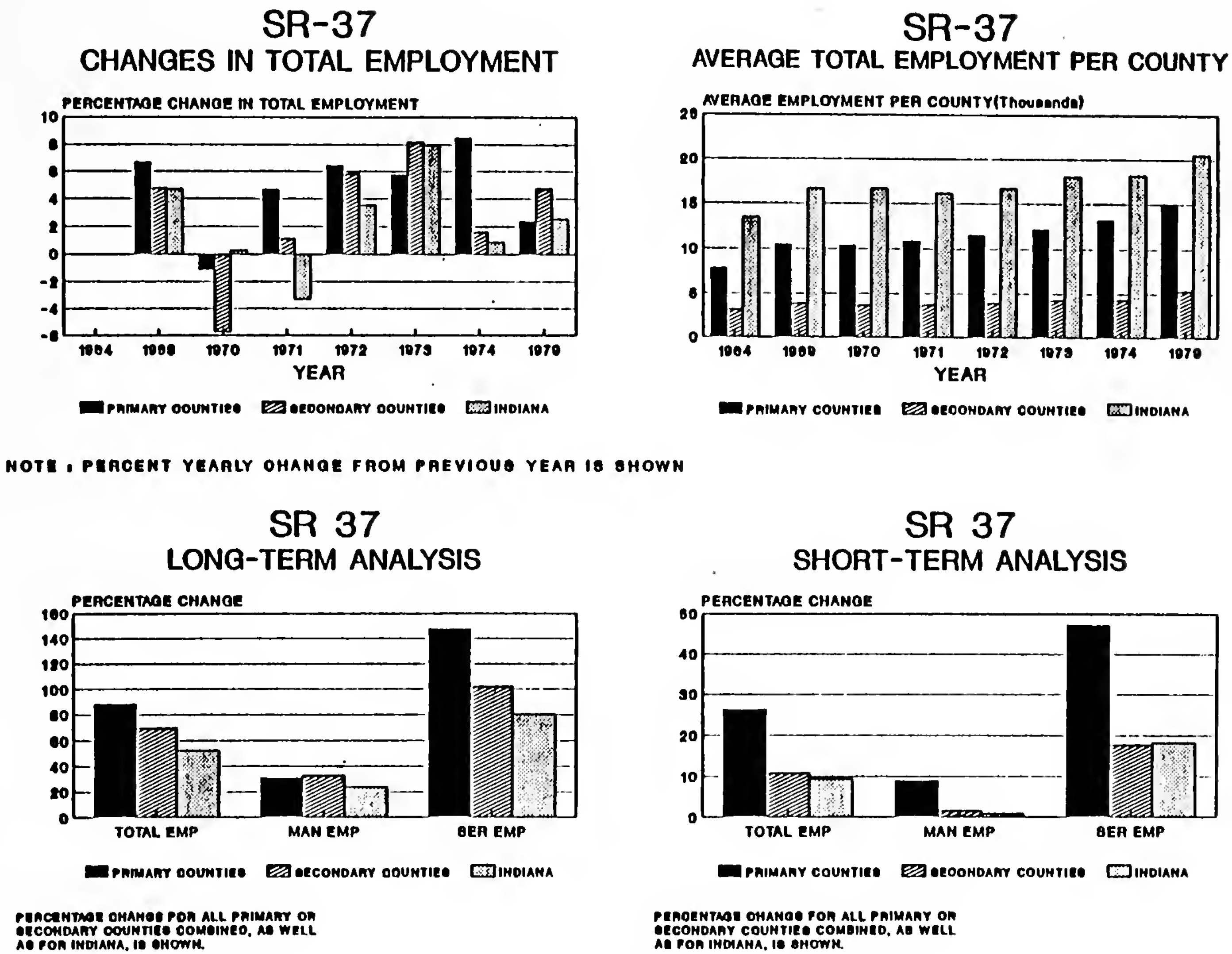


Figure 5.24 Annual, Long- and Short-Term Employment Changes and Annual Employment Base: SR 37

Table 5.12 Results from Comparative Data and t-Tests: SR 37

RESULTS OF COMPARATIVE t-TESTS : SR 37

TESTS FOR YEARLY CHANGES PER COUNTY GROUP : POOLED DATA

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	4.73%	1.91%	7.59%
	ST DEV	3.20%	4.98%	5.02%
	N	7	7	7
SECONDARY :	AVG	2.92%	1.35%	4.24%
	ST DEV	4.51%	7.97%	4.40%
	N	7	7	7
INDIANA :	AVG	2.36%	0.85%	3.79%
	ST DEV	3.57%	4.63%	2.09%
	N	7	7	7
P-VALUES :				
PR VS SEC		>0.10	>0.10	>0.10
PR VS INDIANA		>0.10	>0.10	0.046
SEC VS INDIANA		>0.10	>0.10	>0.10

TESTS FOR INDIVIDUAL COUNTIES IN A GROUP

LONG-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	96.00%	62.09%	133.30%
	ST DEV	40.90%	51.01%	61.96%
	N	4	4	4
SECONDARY :	AVG	81.84%	48.24%	113.83%
	ST DEV	69.27%	54.55%	95.39%
	N	10	10	10
INDIANA		52.21%	23.88%	80.38%
t-TEST P-VALUE		>0.10	>0.10	>0.10

SHORT-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	20.26%	-2.89%	38.54%
	ST DEV	21.44%	20.68%	38.31%
	N	4	4	4
SECONDARY :	AVG	12.18%	12.76%	40.32%
	ST DEV	22.08%	53.15%	70.35%
	N	10	10	10
INDIANA		9.29%	0.91%	18.22%
t-TEST P-VALUE		>0.10	>0.10	>0.10

NOTE : A P-VALUE OF HIGHER THAN 0.10 INDICATES THAT THERE WAS NO SIGNIFICANT DIFFERENCE IN EMPLOYMENT GROWTH BETWEEN THE TWO GROUPS. A POSITIVE P-VALUE OF LESS THAN 0.10 INDICATES THAT THE FIRST GROUP HAD A SIGNIFICANTLY HIGHER EMPLOYMENT GROWTH THAN THE SECOND GROUP, AND A NEGATIVE VALUE THE OPPOSITE.
TOTAL, MANUF AND SERVICE INDICATE RESPECTIVELY DATA CONCERNING TOTAL, MANUFACTURING AND SERVICE EMPLOYMENT.

primary counties led secondary counties, although the only statistically significant difference in average employment change between groups were primary counties over the state in the service sector. Concerning individual counties, no average employment changes were statistically significantly different, although primary counties had a higher average employment change than the other groups in the long term in all economic sectors, and in total employment in the short term.

Analysis of SR 63

SR 63, between US-41 and I-70, was constructed into a four-lane facility from 1972 to 1979, covering a distance of 52 miles in three counties. Although two smaller sections of 1 mile and 3.5 miles were also built, these were omitted for analysis purposes. The location of the road is given in Figure 5.25.

From Figure 5.26, it can be seen that although the average primary county had a larger employment base than secondary counties throughout the time period under consideration, both these groups were smaller in employment base than the state's average county. Year-to-year changes in employment varied widely in size, as well as relatively between the 3 county groups. From the short-term graphical presentation, it is evident that although primary counties lagged secondary counties and the state as a whole in total employment change,

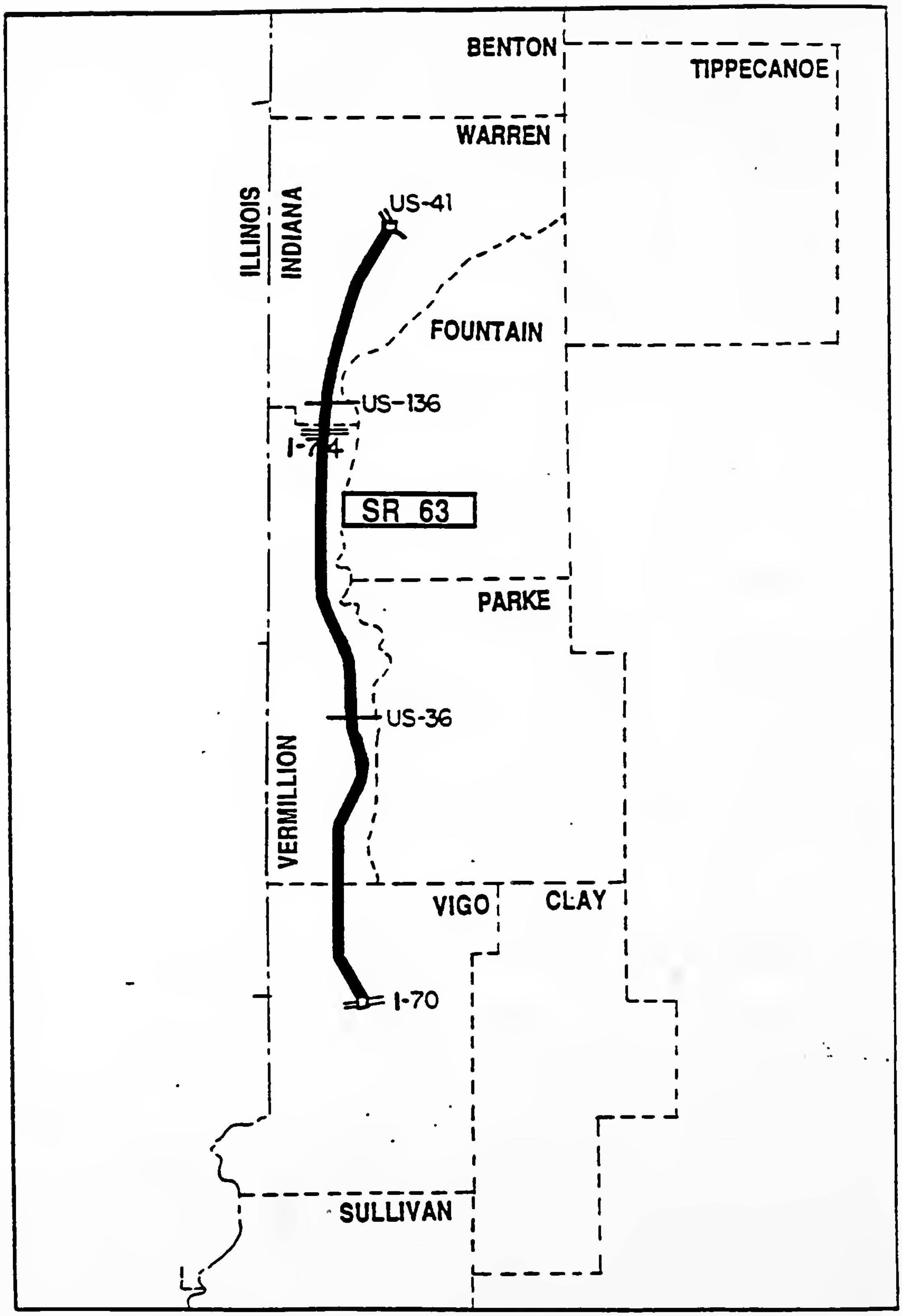
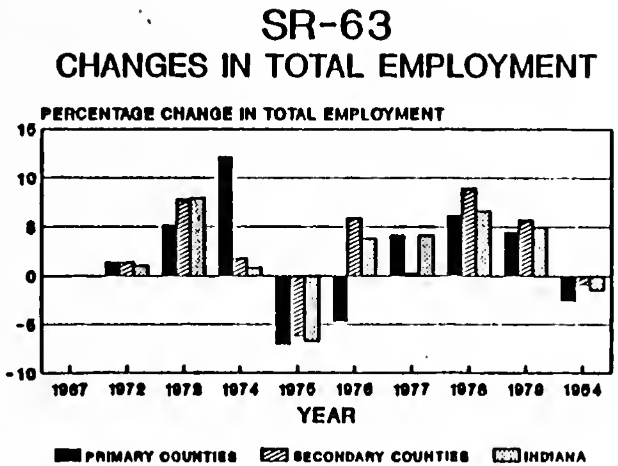
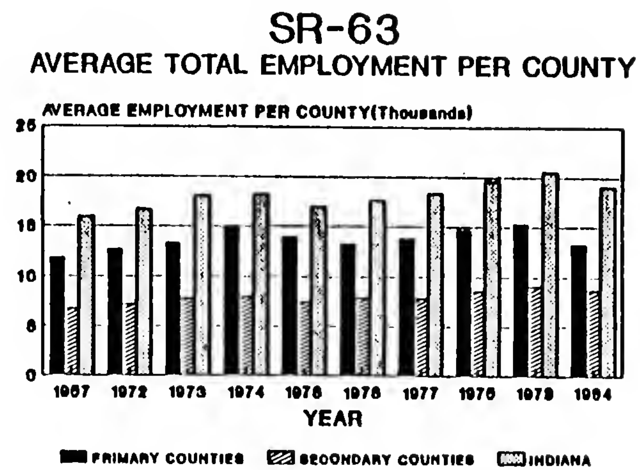
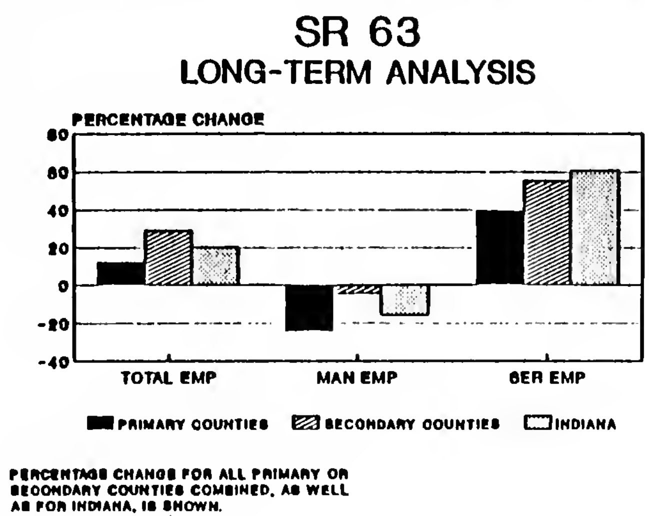


Figure 5.25 Primary and Secondary Counties: SR 63





NOTE : PERCENT YEARLY CHANGE FROM PREVIOUS YEAR IS SHOWN



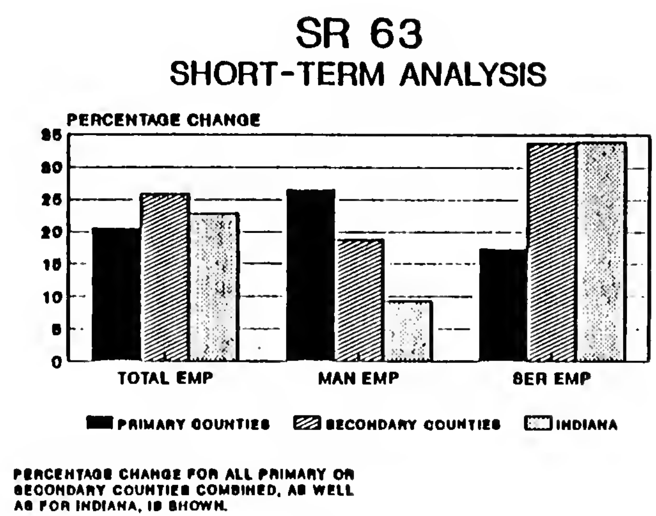


Figure 5.26 Annual, Long- and Short-Term Employment Changes and Annual Employment Base: SR 63

considerable relative growth was experienced in the manufacturing sector. In the long run primary counties lagged the other three groups in all three sectors.

In Table 5.13, annual employment changes showed again that total employment in the primary county group was somewhat lower than secondary counties or the state, as well as service employment, but manufacturing employment changes were the highest in the primary group. None of the comparative tests provided any significant differences. In the short term, individual primary counties had about the same order growth in the total sector, but had higher growth than other county groups in the manufacturing and service sector as well as in almost all sectors over the long term.

Summary and Conclusions

The purpose of this part of the study was to investigate at the corridor level the effects of the construction of a specific four-lane highway on the economic development along the corridor. This was done by determining what the regional changes in employment were on a county-by-county basis during the extended time period of construction. It was appropriate to analyze two types of economic development impacts that highway construction would have, namely an impact over time, and a spatial impact.

Table 5.13 Results from Comparative Data and t-Tests: SR 63

RESULTS OF COMPARATIVE t-TESTS : SR 63

TESTS FOR YEARLY CHANGES PER COUNTY GROUP : POOLED DATA

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	2.12%	1.93%	2.44%
	ST DEV	6.02%	8.54%	7.02%
	N	9	9	9
SECONDARY :	AVG	2.76%	1.76%	3.72%
	ST DEV	4.80%	7.90%	4.23%
	N	9	9	9
INDIANA :	AVG	2.35%	0.62%	3.77%
	ST DEV	4.50%	5.98%	2.73%
	N	9	9	9
P-VALUES :				
PR VS SEC		>0.10	>0.10	>0.10
PR VS INDIANA		>0.10	>0.10	>0.10
SEC VS INDIANA		>0.10	>0.10	>0.10

TESTS FOR INDIVIDUAL COUNTIES IN A GROUP

LONG-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	28.38%	67.28%	48.10%
	ST DEV	76.20%	141.99%	9.86%
	N	3	2	3
SECONDARY :	AVG	18.57%	-0.19%	36.68%
	ST DEV	16.78%	32.80%	15.01%
	N	6	6	6
INDIANA		20.04%	-15.48%	60.93%
t-TEST P-VALUE		>0.10	>0.10	>0.10

SHORT-TERM ANALYSIS : INDIVIDUAL COUNTIES

		TOTAL	MANUF	SERVICE
PRIMARY :	AVG	22.50%	78.89%	35.34%
	ST DEV	36.28%	82.75%	17.91%
	N	3	2	3
SECONDARY :	AVG	23.30%	34.79%	31.50%
	ST DEV	18.68%	40.24%	21.20%
	N	6	6	6
INDIANA		22.80%	9.29%	33.89%
t-TEST P-VALUE		>0.10	>0.10	>0.10

NOTE : A P-VALUE OF HIGHER THAN 0.10 INDICATES THAT THERE WAS NO SIGNIFICANT DIFFERENCE IN EMPLOYMENT GROWTH BETWEEN THE TWO GROUPS. A POSITIVE P-VALUE OF LESS THAN 0.10 INDICATES THAT THE FIRST GROUP HAD A SIGNIFICANTLY HIGHER EMPLOYMENT GROWTH THAN THE SECOND GROUP, AND A NEGATIVE VALUE THE OPPOSITE.
TOTAL, MANUF AND SERVICE INDICATE RESPECTIVELY DATA CONCERNING TOTAL, MANUFACTURING AND SERVICE EMPLOYMENT.

The impact over time would vary. As the construction of the four-lane commenced, direct impacts such as an increase in construction employment and highway materials acquisition would be expected. Indirect effects, such as the spending and re-spending of capital from the project would occur throughout the local economy. Towards the end of the project and during the post-construction period the direct effects would decrease, while the indirect impacts would increase as accessibility to the region was improved, highway user costs associated with the opening of the new highway would decrease, and manufacturing industries would be attracted to the region. It was hypothesized that these indirect effects would be of a more long-term nature.

The spatial impact of a specific four-lane project was hypothesized to be concentrated in the immediate region of the project, namely primary counties. It is of course possible that secondary counties would also benefit from a project, due to their proximity to primary counties, and depending on labor and materials availability in primary counties. Overall, primary and secondary counties were hypothesized to benefit more than the state as a whole from a project. There are logically some benefits that can not be attributed to or realized in the immediate region. An example of this would be advantages to through-truck traffic and other non-local road-users.

The analysis methodology that was used in this part of the study was aimed at investigating at the county level the aggregate changes in employment in the three broad economic sectors, namely manufacturing, service and total industry, on an annual basis. It could therefore not be expected that the impact of a four-lane project on a specific industry would be confirmed, but more general tendencies over a wide range of projects could be observed. The purpose of the adopted methodology was therefore to subject all nine four-lane corridors to a structured analysis, and search for trends.

Initially, data for all counties in a specific classification were pooled and analyzed from year to year over both the long- and the short term, to contrast groups to each other. Summary ranked results are presented in Table 5.14. Over the short term, it was found that for the twelve individual sections considered (US-31 Section 1 did not have any short-term data), primary counties and secondary counties as separate groups had a higher total employment increase than the state in respectively 6 and 7 sections. Primary counties exceeded secondary counties in 7 cases.

Over the long-term, there were also twelve sections considered, due to no long-term data available for US-41 South Section 1. Primary counties' total annual employment change exceeded the state again in six highway sections, while secondary counties outperformed the state in nine out of the

Table 5.14 Ranked Results from Pooled Data Analysis

POOLED DATA : SHORT TERM PERCENTAGE EMPLOYMENT CHANGES

SECTION	TOTAL			MANUFG			SERVICE		
	HI	MID	LO	HI	MID	LO	HI	MID	LO
I-64	PRI	SEC	IND	IND	PRI	SEC	SEC	PRI	IND
I-70 Section 1	PRI	IND	SEC	PRI	IND	SEC	PRI	IND	SEC
I-70 Section 2	IND	SEC	PRI	IND	SEC	PRI	IND	SEC	PRI
I-74	IND	PRI	SEC	SEC	PRI	IND	IND	PRI	SEC
US-30 Section 1	PRI	SEC	IND	SEC	PRI	IND	PRI	SEC	IND
US-30 Section 2	PRI	SEC	IND	PRI	SEC	IND	PRI	SEC	IND
US-31 Section 1	-	-	-	-	-	-	-	-	-
US-31 Section 2	IND	PRI	SEC	IND	SEC	PRI	PRI	IND	SEC
US-41 North	SEC	PRI	IND	SEC	PRI	IND	PRI	SEC	IND
US-41 S Section 1	IND	SEC	PRI	SEC	PRI	IND	SEC	IND	PRI
US-41 S Section 2	SEC	IND	PRI	SEC	IND	PRI	SEC	PRI	IND
SR 37	PRI	SEC	IND	PRI	SEC	IND	PRI	IND	SEC
SR 63	SEC	IND	PRI	PRI	SEC	IND	IND	SEC	PRI

POOLED DATA : LONG TERM PERCENTAGE EMPLOYMENT CHANGES

SECTION	TOTAL			MANUFG			SERVICE		
	HI	MID	LO	HI	MID	LO	HI	MID	LO
I-64	SEC	PRI	IND	SEC	PRI	IND	SEC	PRI	IND
I-70 Section 1	IND	PRI	SEC	IND	SEC	PRI	PRI	IND	SEC
I-70 Section 2	IND	PRI	SEC	IND	PRI	SEC	IND	SEC	PRI
I-74	PRI	SEC	IND	PRI	SEC	IND	SEC	IND	PRI
US-30 Section 1	SEC	PRI	IND	SEC	PRI	IND	PRI	SEC	IND
US-30 Section 2	PRI	SEC	IND	PRI	SEC	IND	PRI	SEC	IND
US-31 Section 1	SEC	IND	PRI	SEC	PRI	IND	SEC	IND	PRI
US-31 Section 2	PRI	IND	SEC	PRI	IND	SEC	IND	PRI	SEC
US-41 North	SEC	IND	PRI	PRI	SEC	IND	SEC	IND	PRI
US-41 S Section 1	-	-	-	-	-	-	-	-	-
US-41 S Section 2	SEC	IND	PRI	SEC	IND	PRI	IND	SEC	PRI
SR 37	PRI	SEC	IND	SEC	PRI	IND	PRI	SEC	IND
SR 63	SEC	IND	PRI	SEC	IND	PRI	IND	SEC	PRI

PRI = PRIMARY COUNTIES
SEC = SECONDARY COUNTIES
IND = AVERAGE INDIANA COUNTIES
HI = COUNTY GROUP WITH HIGHEST PERCENTAGE CHANGE
MED = COUNTY GROUP WITH MIDDLE PERCENTAGE CHANGE
LO = COUNTY GROUP WITH LOWEST PERCENTAGE CHANGE
\- = NO DATA AVAILABLE

Table 5.14, continued

POOLED DATA : ANNUAL PERCENTAGE EMLOYMENT CHANGES

SECTION	TOTAL			MANUFG			SERVICE		
	HI	MID	LO	HI	MID	LO	HI	MID	LO
I-64	SEC	PRI	IND	PRI	IND	SEC	SEC	PRI	IND
I-70 Section 1	IND	PRI	SEC	SEC	IND	PRI	PRI	IND	SEC
I-70 Section 2	IND	SEC	PRI	IND	PRI	SEC	IND	SEC	PRI
I-74	SEC	PRI	IND	SEC	PRI	IND	IND	SEC	PRI
US-30 Section 1	SEC	PRI	IND	SEC	PRI	IND	PRI	SEC	IND
US-30 Section 2	PRI	SEC	IND	PRI	SEC	IND	PRI	SEC	IND
US-31 Section 1	SEC	IND	PRI	SEC	PRI	IND	SEC	IND	PRI
US-31 Section 2	PRI	IND	SEC	PRI	IND	SEC	PRI	IND	SEC
US-41 North	SEC	PRI	IND	PRI	SEC	IND	PRI	SEC	IND
US-41 S Section 1	IND	PRI	SEC	SEC	IND	PRI	PRI	IND	SEC
US-41 S Section 2	SEC	IND	PRI	SEC	IND	PRI	SEC	IND	PRI
SR 37	PRI	SEC	IND	PRI	SEC	IND	PRI	SEC	IND
SR 63	SEC	IND	PRI	PRI	SEC	IND	IND	SEC	PRI

PRI = PRIMARY COUNTIES
SEC = SECONDARY COUNTIES
IND = AVERAGE INDIANA COUNTIES
HI = COUNTY GROUP WITH HIGHEST PERCENTAGE CHANGE
MED = COUNTY GROUP WITH MIDDLE PERCENTAGE CHANGE
LO = COUNTY GROUP WITH LOWEST PERCENTAGE CHANGE
- = NO DATA AVAILABLE

total of twelve sections. Primary and secondary county changes surpassed each other in six of the sections each.

Concerning the mean annual percentage change in total employment on the basis of data pooled by county group, it was found that primary counties had a higher average value than secondary counties in five of the thirteen sections, and exceeded the state's average in 7 sections, as shown in Table 5.14. This latter figure for secondary counties was 9 sections. Two-sided t-tests were performed to investigate whether there was a statistically significant difference in annual employment change between primary and secondary counties over the pre- to post-construction period. This comparative analysis was also performed for primary county change versus employment change in Indiana as a whole, and secondary counties versus the state, in all 13 four-lane sections. Primary counties were found to have a significantly higher average employment change than the state in only one section and industry group, namely in service employment concerning SR 37. Secondary counties were found to have a significant increase over primary counties in only US-31 Section 1, in the service sector. In the remaining 11 sections no statistically significant difference were found between any county groups, in any employment sector.

Subsequently, short-term and long-term changes for individual counties within the primary and the secondary county groups

were examined. The mean changes for these two groups were examined, and contrasted to the state. Summary ranked results are presented in Table 5.15. Over the short term, primary counties had a higher average employment increase in total employment per county than secondary counties in 5 sections, and higher than the state in 6 sections. Secondary counties had a higher average than the state in 10 of the 12 sections. In the long run primary counties outperformed secondary counties in 8 sections, and the state in 8 sections. This latter figure for secondary counties versus the state was 10 sections. Primary counties also displayed the highest long-term total employment changes of all three county groups in 8 of the 12 sections.

Two-sided t-tests were performed to detect statistically significant differences. The state's economic growth could however not be included in the statistical tests. In the short term, there were no statistically significantly different mean increases in employment in any of the county groups or sectors. Over the long term, primary counties outperformed secondary counties in 2 sections, while the converse was true in 1 section.

In summary, the following conclusions can be made :

The evidence from this study appears to indicate that the region in which a four-lane highway was built, i.e. including

Table 5.15 Ranked Results from Individual County Analysis

INDIVIDUAL COUNTY DATA: SHORT-TERM PERCENTAGE EMPLOYMENT CHANGES

SECTION	TOTAL			MANUFG			SERVICE		
	HI	MID	LO	HI	MID	LO	HI	MID	LO
I-64	PRI	SEC	IND	PRI	IND	SEC	PRI	SEC	IND
I-70 Section 1	PRI	IND	SEC	PRI	IND	SEC	PRI	IND	SEC
I-70 Section 2	SEC	IND	PRI	SEC	IND	PRI	SEC	IND	PRI
I-74	SEC	IND	PRI	SEC	PRI	IND	IND	SEC	PRI
US-30 Section 1	SEC	IND	PRI	SEC	IND	PRI	PRI	SEC	IND
US-30 Section 2	PRI	SEC	IND	SEC	PRI	IND	PRI	SEC	IND
US-31 Section 1	-	-	-	-	-	-	-	-	-
US-31 Section 2	PRI	SEC	IND	PRI	SEC	IND	PRI	IND	SEC
US-41 North	SEC	PRI	IND	SEC	PRI	IND	PRI	SEC	IND
US-41 S Section 1	IND	SEC	PRI	SEC	PRI	IND	SEC	IND	PRI
US-41 S Section 2	SEC	IND	PRI	SEC	IND	PRI	SEC	PRI	IND
SR 37	PRI	SEC	IND	SEC	IND	PRI	SEC	PRI	IND
SR 63	SEC	IND	PRI	PRI	SEC	IND	PRI	IND	SEC

INDIVIDUAL COUNTY DATA: LONG-TERM PERCENTAGE EMPLOYMENT CHANGES

SECTION	TOTAL			MANUFG			SERVICE		
	HI	MID	LO	HI	MID	LO	HI	MID	LO
I-64	PRI	SEC	IND	PRI	SEC	IND	PRI	IND	SEC
I-70 Section 1	IND	SEC	PRI	SEC	IND	PRI	PRI	IND	SEC
I-70 Section 2	PRI	SEC	IND	PRI	SEC	IND	PRI	IND	SEC
I-74	PRI	SEC	IND	PRI	SEC	IND	IND	SEC	PRI
US-30 Section 1	PRI	SEC	IND	SEC	PRI	IND	PRI	IND	SEC
US-30 Section 2	PRI	SEC	IND	PRI	SEC	IND	PRI	SEC	IND
US-31 Section 1	SEC	IND	PRI	SEC	PRI	IND	SEC	IND	PRI
US-31 Section 2	PRI	SEC	IND	PRI	SEC	IND	IND	SEC	PRI
US-41 North	SEC	IND	PRI	SEC	PRI	IND	SEC	IND	PRI
US-41 S Section 1	-	-	-	-	-	-	-	-	-
US-41 S Section 2	SEC	IND	PRI	SEC	IND	PRI	IND	SEC	PRI
SR 37	PRI	SEC	IND	PRI	SEC	IND	PRI	SEC	IND
SR 63	PRI	IND	SEC	PRI	SEC	IND	IND	PRI	SEC

PRI = PRIMARY COUNTIES
SEC = SECONDARY COUNTIES
IND = AVERAGE INDIANA COUNTIES
HI = COUNTY GROUP WITH HIGHEST PERCENTAGE CHANGE
MED = COUNTY GROUP WITH MIDDLE PERCENTAGE CHANGE
LO = COUNTY GROUP WITH LOWEST PERCENTAGE CHANGE
- = NO DATA AVAILABLE

both primary and secondary counties, showed a higher mean annual economic growth than the state, although there was not adequate statistical evidence to support this conclusion in most cases. This can be ascribed to the confounding of many other factors that were not included in the analysis due to data availability and for simplicity purposes, but that were proved in earlier parts of the study to affect economic development to some extent. Also, a relatively high level of significance was used, increasing the probability of not detecting any significant differences between county groups. Although primary and secondary counties showed higher economic development than the state of Indiana over the time period of construction of a four-lane highway in some cases, as measured by changes in employment over time, this was not significant in many cases.

Although primary counties were hypothesized to benefit more than secondary counties in terms of the economic development benefits of the construction of a four-lane highway, this hypothesis could not be proved conclusively. Three reasons can be cited for this. Firstly, the region as a whole may benefit from the construction of a four-lane highway, and not specifically the primary counties. Especially where construction is undertaken through small rural counties, adjacent larger counties could be expected to supply resources for the project, and thus secondary counties would realize extensive benefits from the project. Secondly, the variance in

employment growth in individual counties was so great that there was little statistically significant differences, although the mean values varied. A more detailed study at the disaggregate city and town economy level and for specific industries, would be necessary to determine the particular effects of a highway construction on the local economy. Thirdly, in some cases such as US-41 Section 1 (12 miles), and US-31 Section 1 (10 miles), the highway project was so relatively small that probably only a marginal impact was made on the local economy.

Concerning economic development in individual counties over the extended construction period of a four-lane highway, evidence suggests that counties with highways constructed through them i.e. primary counties, benefitted more than adjacent or secondary counties as well as the state. More regional benefits, i.e. in both primary and secondary counties, did appear to be derived from four-lane facility construction over the long term than the short term. In a majority of the sections that were investigated, these counties seemed to show more economic growth than the state as a whole.

In conclusion, this part of the study showed that although it is complex to isolate, measure and quantify the regional economic development benefits of the construction of four-lane highways in Indiana, such facility construction, together with

other economic determinants, have a higher probability of resulting in increased economic activity over the construction period and beyond in counties in the region.

CHAPTER 6

INDUSTRIAL LOCATION DETERMINANT ANALYSIS

It is a well-known fact that when industries make decisions as to where they should physically locate, several characteristics or attributes that are desirable for the specific industry are considered. These characteristics or locational factors can vary from the general geographic area of the country where the firm perceives it will have good access to its most prominent market areas, to site-specific characteristics. Weighting of these factors in importance allows an industrialist to choose between competing sites in a specific state or county.

For many years and in many studies, some of which were discussed in the literature review, there has been an effort to identify which locational factors are important, to what extent, and to which industries. In the early 1970s, a study was undertaken by the Economic Development Administration of the US Department of Commerce to determine industrial location determinants for industries with Standard Industrial Classification (SIC) codes between 20 and 39, i.e. manufacturing industries [USDOC, 1973]. This study dealt with industries which had shown reasonable growth between 1958 and

1967, or appeared to have growth potential in the 1970s. The industries were identified by their Bureau of the Census 5-digit product class code number, and a total of 2,950 firms in 254 of these classes was selected for the survey. The response rate was 70 percent for this part of the study in the early 1970s. Data were obtained on the locational preferences of companies, covering such issues as community size, plant size, community attributes, and plant size features. Several of the variables included in the USDOC study dealt with transportation, but also with other variables that were considered in this study. An analysis of these data, and consideration of the results from the analysis, were deemed important for the current study, as that would give a quantitative as well as relative indication of how industries consider transportation and related factors when making locational decisions.

Data Analysis

As a first step, variables or locational indicators were identified that were dealt with in the USDOC study, and that would provide data for analysis. The transportation variables that were identified are the following :

- air passenger service;
- contract trucking;
- highway access (within 30 minutes of a major highway interchange);

- scheduled air freight service;
- water transportation;
- scheduled rail service.

Other locational preference variables that were related to this study and that were also included are the following :
- higher educational facilities;
- tax incentives or tax holidays;
- the pool of trained workers;
- the treated industrial water supply.

For each of these indicators in the USDOC study, industrialists that were surveyed had to indicate if the variable had been of critical value, of significant to average value, or of minimal value when they made a decision to establish their industry in a specific location. After the relevant data on the above-mentioned ten variables had been extracted to a data base, the data were adjusted upward proportionally to allow for data entries which included no responses.

In order to consolidate the data for simplified interpretation, it was decided to determine if data could be combined or pooled into 2-digit SIC codes, thereby reducing the 254 codes to 20 codes from SIC code 20 to 39. The testing procedure that was used is the chi-square test for contingency tables [Conover 1971]. This test determines if observations

from different populations, in this case the different product groups, vary significantly across the various classes or categories in which observations were made. If there was no significant difference between classes at the 95% level of significance, data were pooled for the specific SIC code.

The first series of tests were done for the transportation variables, and Table 6.1 shows the results. It should be noted that in some cases pooling was marginal, i.e. the p-value for the test was between 0.025 and 0.05, and the data were pooled in those instances.

Table 6.2 shows the data after pooling. It should be noted that no industries in SIC codes 21, 23 and 31 were included in the survey. Table 6.2 also presents a brief description of each of the SIC codes, the number of 5-digit codes that had been included under each 2-digit code, and the total number of responses in the code group. For the industries for which data could not be pooled, it could be concluded that the importance of transportation variables differed significantly between the industries that were included in the sample. Consequently, another set of tests was done on the contract trucking and highway access data for industries within the same 2-digit SIC for which data could not be pooled. These two indicators relate directly to highway importance. Groupings for the tests in these cases were done according to meaningful product categorizing in the original study. Table 6.3 shows the pooled

Table 6.1 Transportation Indicators: Summary of Chi-Square Pooling Test Results

SIC CODE	# BEA GRPS	AIR PASSNGR SERVICE	CONTRACT TRUCKING	HIGHWAY ACCESS	SCHEDULED AIR FRT SERVICE	WATER TRANSP	RAIL SERVICE
		CAN DATA BE POOLED?					
20	1	N/A	N/A	N/A	N/A	N/A	N/A
22	4	Y	Y	Y	Y*	Y	Y
24	3	Y	Y*	Y	Y	Y	Y
25	5	Y	Y	Y	Y	Y	Y
26	10	Y	Y	Y	Y	N	Y
27	12	Y	N	N	N	Y	Y
28	16	Y	Y	Y	Y	N	N
29	2	N	Y	Y	Y	Y*	Y
30	4	Y	Y	Y	Y	Y	N
32	4	Y	Y	Y	Y	Y	Y
33	18	Y	Y	Y*	Y	Y	N
34	24	N	Y	Y	N	N	N
35	65	Y	Y	Y	Y*	Y	N
36	30	N	Y	Y	N	Y	N
37	7	Y	Y	N	Y	Y*	N
38	14	N	Y	Y	N	Y	Y
39	3	Y	Y*	Y	Y*	Y	Y

NOTE : Y* INDICATES A MARGINAL DECISION TO POOL
(P-VALUE IS BETWEEN 0.025 AND 0.05)
Y = YES, N = NO, N/A = NOT APPLICABLE

Table 6.2 Importance of Transportation Indicators to Manufacturing Industries

SIC CODE	INDUSTRY DESCRIPTION	# 5-DIGIT CODES	# RESP	AIR PASSNGR SERVICE			CONTRACT TRUCKING			HIGHWAY ACCESSIBLTY			SCHED AIR FREIGHT SVC			WATER TRANSPORTATN			CONTRACT RAIL SERVICE		
				A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
20	SOFT DRINKS	1	56	4	32	63	19	49	32	50	41	9	4	45	51	2	10	88	10	40	51
22	TEXTILE MILL PRODUCTS	4	66	12	41	47	33	41	25	39	61	0	8	47	45	0	6	94	21	39	40
24	WOOD PRODUCTS	3	27	0	47	53	7	81	11	33	56	11	0	39	61	8	38	55	84	11	5
25	FURNITURE AND FIXTURES	5	55	13	63	24	38	46	15	38	60	2	15	59	26	0	6	94	23	46	30
26	PULP, PAPER, AND BOARD PRODUCTS	11	71	15	51	34	33	56	12	46	53	1	17	39	45	*	*	*	74	21	5
27	PUBLISHING AND PRINTING	12	166	16	51	33	*	*	*	*	*	*	*	*	*	1	4	95	25	36	40
28	CHEMICALS AND ALLIED PRODUCTS	16	120	9	61	30	31	56	12	37	60	3	7	63	21	*	*	*	*	*	*
29	PETROLEUM AND COAL PRODUCTS	2	11	*	*	*	21	70	9	11	71	18	0	57	43	18	45	36	48	41	11
30	MISC. PLASTIC PRODUCTS	4	102	10	59	31	39	47	15	41	56	3	11	65	24	2	11	87	*	*	*
32	GLASS PRODUCTS AND MINERAL WOOL	4	27	12	56	32	28	48	23	37	59	4	8	36	56	0	8	92	67	33	0
33	PRIMARY METAL INDUSTRIES	18	279	7	49	43	31	57	12	36	60	4	5	46	49	1	14	85	*	*	*
34	FABRICATED METAL PRODUCTS	24	398	*	*	*	35	48	17	41	56	3	*	*	*	*	*	*	*	*	*
35	MACHINERY, EXCLUDING ELECTRICAL	65	642	13	61	25	32	50	18	36	60	3	15	69	16	1	15	83	*	*	*
36	ELECTRICAL MACHINARY,EQPMNT,SUPPLS	30	315	*	*	*	25	55	20	33	64	3	*	*	*	1	6	93	*	*	*
37	TRANSPORTATION EQUIPMENT	7	68	0	67	33	27	42	31	*	*	*	3	47	50	4	12	84	*	*	*
38	INSTRUMENTS, PHOTOGR+OPTICL GOODS	14	117	*	*	*	31	51	18	29	66	5	*	*	*	2	9	89	5	35	60
39	MISCELANEOUS MANUFACTURED PRODUCTS	3	56	9	41	50	44	36	20	40	56	4	13	59	28	0	15	85	24	35	41

LEGEND : A = OF CRITICAL VALUE
B = OF SIGNIFICANT TO AVERAGE VALUE
C = OF MINIMAL VALUE
*=DATA FOR INDUSTRIES IN THIS CLASSIFICATION AND CATEGORY COULD NOT BE POOLED

Table 6.3 Pooled Data for SIC Code 27: Contract Trucking

SIC CODE	INDUSTRY DESCRIPTION	# RESP	TRUCKING A	B	C
27521-6	COMMERCIAL PRINTING	73	52	40	8
27611-2	MAINFOLD BUSINESS FORMS	33	26	58	16
27891/910	PRINTING TRADE	30	18	25	57

*NOTE : THESE ARE INDUSTRIES WITHIN THE SAME 2-DIGIT SIC CODE FOR WHICH DATA COULD NOT BE POOLED

LEGEND : A = OF CRITICAL VALUE
B = OF SIGNIFICANT TO AVERAGE VALUE
C = OF MINIMAL VALUE

data for the importance of contract trucking to the various industries in SIC code 27, and Table 6.4 gives the importance of highway access with respect to SIC codes 27 and 37.

The tests were also done for the four remaining indicators, and the results are shown in Table 6.5. From this table it is evident that for most of the four variables and SIC codes, there were no significant difference for classes within codes. The pooled data are presented in Table 6.6, in a format that is similar to Table 6.2.

Discussion of Results

Figures 6.1 to 6.12 give graphic presentations of each of the ten variables that were investigated in this analysis. The graphs show the importance of each variable concerning location determination for the industries that were included in the sample. The SIC codes that are presented in each graph are those for which data were available, and for which data could be pooled under the specific variable's chi-square test. A discussion of each variable's results follows.

Air Passenger Service

Figure 6.1 shows the importance of air passenger service availability in a specific location influencing industries to locate there. From the figure it is evident that this variable

Table 6.4 Pooled Data for SIC Codes 27 and 33: Highway Access

SIC CODE	INDUSTRY DESCRIPTION	# RESP	HWY ACCESS A	B	C
27321-2	PRINTING AND BINDING	30	33	67	0
27521-6	COMMERCIAL PRINTING	73	51	45	4
27611-2	MANIFOLD BUSINESS FORMS	33	55	45	0
33212/4/20/31-3	FOUNDRY PRODUCTS	148	37	58	5
33512/22/5	ROLLERS/DRAWERS:NONFERROUS METALS	20	25	75	0
33991/6	STEEL MILLS	31	34	66	0

*NOTE : THESE ARE INDUSTRIES WITHIN THE SAME 2-DIGIT SIC CODE FOR WHICH DATA COULD NOT BE POOLED

LEGEND : A = OF CRITICAL VALUE
B = OF SIGNIFICANT TO AVERAGE VALUE
C = OF MINIMAL VALUE

Table 6.5 Other Indicators: Summary of Chi-Square Pooling Tests

SIC CODE	# BEA GRPS	CAN DATA BE POOLED? HIGHER EDUCATIONAL FACILITIES	TAX INCENTIVES	TRAINED WORKERS	INDUSTRIAL WATER SUPPLY
20	1	N/A	N/A	N/A	N/A
22	4	Y	Y*	Y	Y
24	3	Y	Y	Y	Y
25	5	Y	Y	Y	Y
26	10	Y	Y	Y	Y
27	12	Y	Y	N	N
28	16	Y	Y	Y	Y
29	2	N	Y	Y	Y
30	4	Y	Y	Y	Y
32	4	Y	Y	Y	N
33	18	Y	Y	Y	Y
34	24	Y	Y	Y	N
35	65	Y	Y	Y	Y
36	30	Y	Y	Y	Y
37	7	Y	Y	Y	Y*
38	14	Y	Y	Y	Y
39	3	Y	Y	Y*	Y

NOTE : Y* INDICATES THAT THE DECISION TO POOL IS MARGINAL
(P-VALUE IS BETWEEN 0.025 AND 0.05)
Y = YES, N = NO, N/A = NOT APPLICABLE

Table 6.6 Importance of Other Indicators to Manufacturing Industries

SIC CODE	INDUSTRY DESCRIPTION	# 5-DIGIT CODES	# RESP	HIGHER EDUC FACILITIES			TAX INCENTIVES			TRAINED WORKERS			INDUSTRIAL WATER SUPPLY		
				A	B	C	A	B	C	A	B	C	A	B	C
20	SOFT DRINKS	1	56	2	59	39	9	74	17	2	75	23	68	24	7
22	TEXTILE MILL PRODUCTS	4	66	5	36	59	8	74	18	10	82	8	46	44	10
24	WOOD PRODUCTS	3	27	0	41	59	8	70	23	0	80	20	27	47	27
25	FURNITURE AND FIXTURES	5	55	0	54	46	14	76	10	23	71	6	28	60	12
26	PULP, PAPER, AND BOARD PRODUCTS	11	111	0	41	59	10	72	18	11	77	12	30	53	18
27	PUBLISHING AND PRINTING	12	166	2	56	41	13	68	19	#	#	#	#	#	#
28	CHEMICALS AND ALLIED PRODUCTS	16	120	#	#	#	6	75	19	13	75	12	30	48	22
29	PETROLEUM AND COAL PRODUCTS	2	11	0	55	45	0	89	11	9	79	11	0	59	41
30	MISC. PLASTIC PRODUCTS	4	102	2	51	47	8	66	25	11	76	13	#	#	#
32	GLASS PRODUCTS AND MINERAL WOOL	4	27	0	65	35	15	70	15	8	84	8	24	65	11
33	PRIMARY METAL INDUSTRIES	18	279	1	52	47	10	71	19	16	70	14	#	#	#
34	FABRICATED METAL PRODUCTS	24	398	1	54	45	7	74	19	20	73	7	21	54	26
35	MACHINERY, EXCLUDING ELECTRICAL	65	642	1	64	34	8	72	20	26	70	5	18	56	26
36	ELECTRICAL MACHINARY,EQPMNT,SUPPLS	30	315	3	64	34	8	69	23	17	71	12	20	61	19
37	TRANSPORTATION EQUIPMENT	7	68	2	43	55	5	77	19	15	66	19	12	53	34
38	INSTRUMENTS, PHOTOGR+OPTICL GOODS	14	117	1	69	30	6	74	20	23	69	8	23	55	22
39	MISCELANEOUS MANUFACTURED PRODUCTS	3	56	0	53	47	8	85	8	16	61	23	19	50	31

LEGEND : A = OF CRITICAL VALUE
B = OF SIGNIFICANT TO AVERAGE VALUE
C = OF MINIMAL VALUE
#=DATA FOR INDUSTRIES IN THIS CLASSIFICATION AND CATEGORY COULD NOT BE POOLED

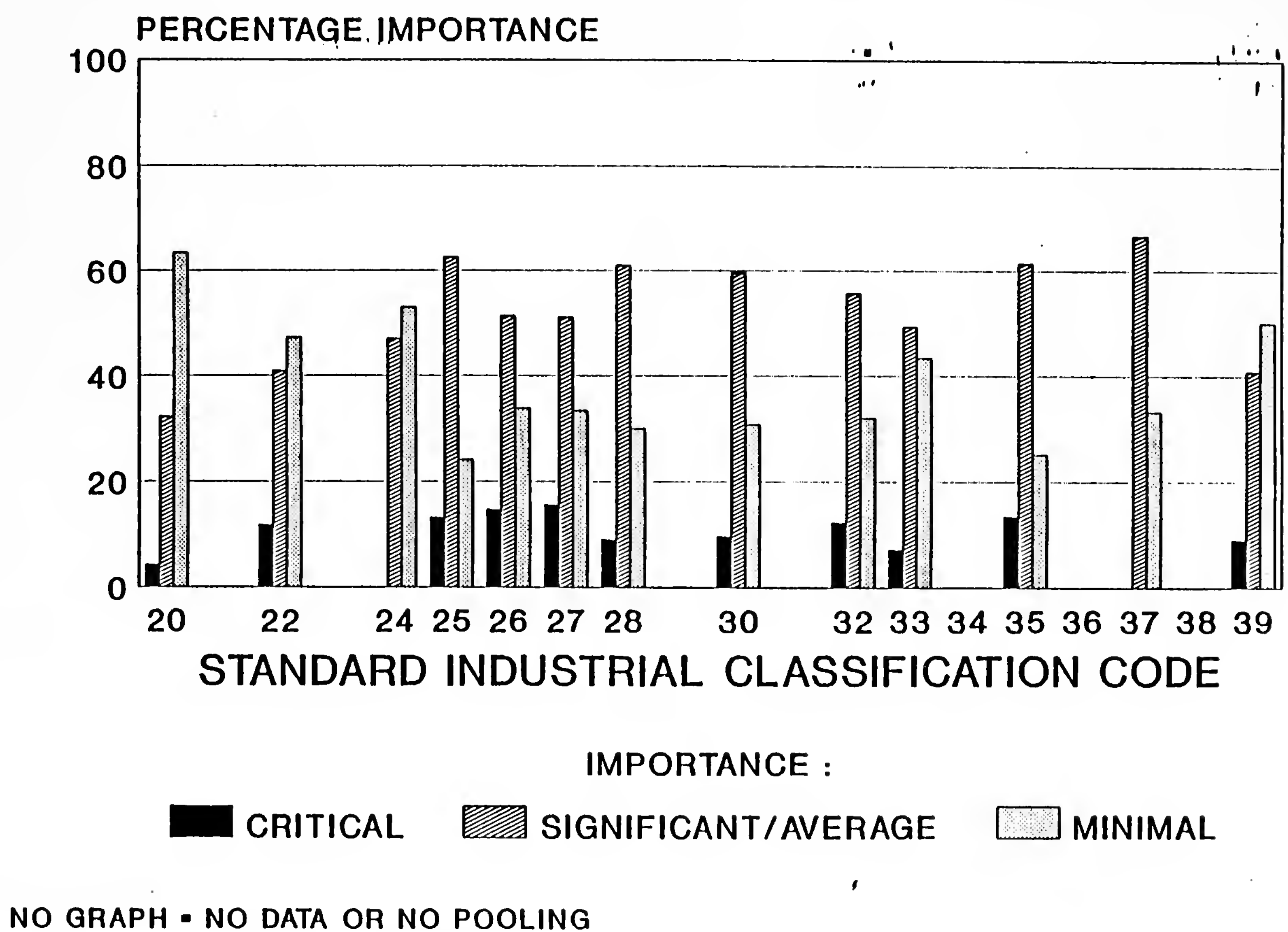


Figure 6.1 Percentage Importance of Air Passenger Service

is of critical importance to an average of about 10 percent of the industries in the sample. In the significant to average categories, the results were widely varying, implying that different types of industries have varying degrees of reliance on the air passenger service availability in a location.

Contract Trucking Availability

In Figure 6.2, the availability of contract trucking as a determinant of industrial location for the industries in the sample is presented. The graph shows clearly that for the majority of industries this indicator varied from critical to average importance. For roughly 30 percent of industries in the sample contract trucking is a critical location determinant, while for between 40 and 80 percent of industries it has a significant to average importance.

Highway Accessibility

Figure 6.3 shows how important it was for industries in the sample to locate within 30 minutes' driving time from a major highway interchange. It is clear from the graph that all industries in the sample placed a high premium on highway accessibility when deciding in which location to situate. For an average of roughly 40 percent this determinant was of critical importance, and for about 60 percent it had a significant to average importance. Only SIC code 29 (petroleum

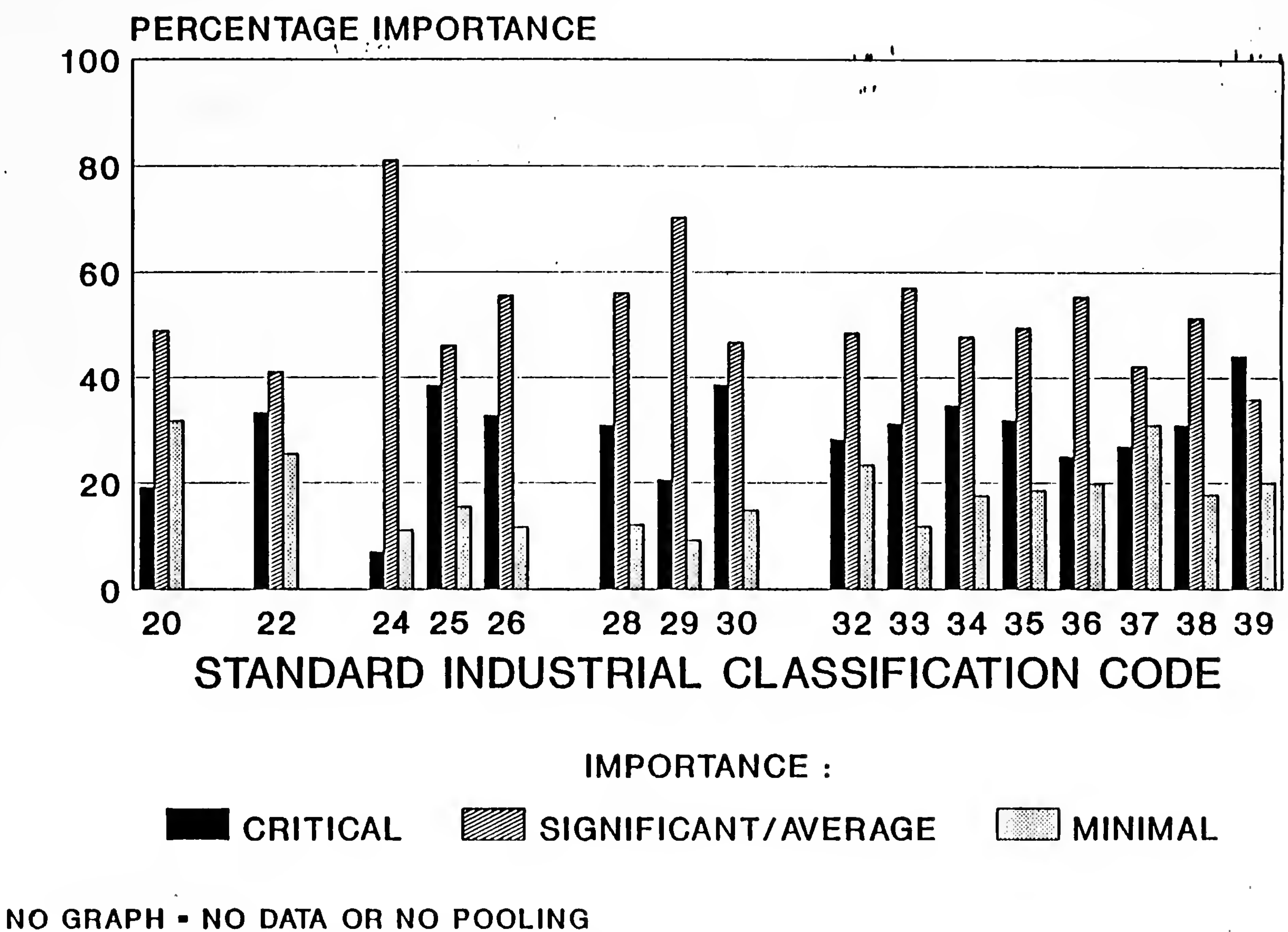


Figure 6.2 Percentage Importance of Contract Trucking Availability

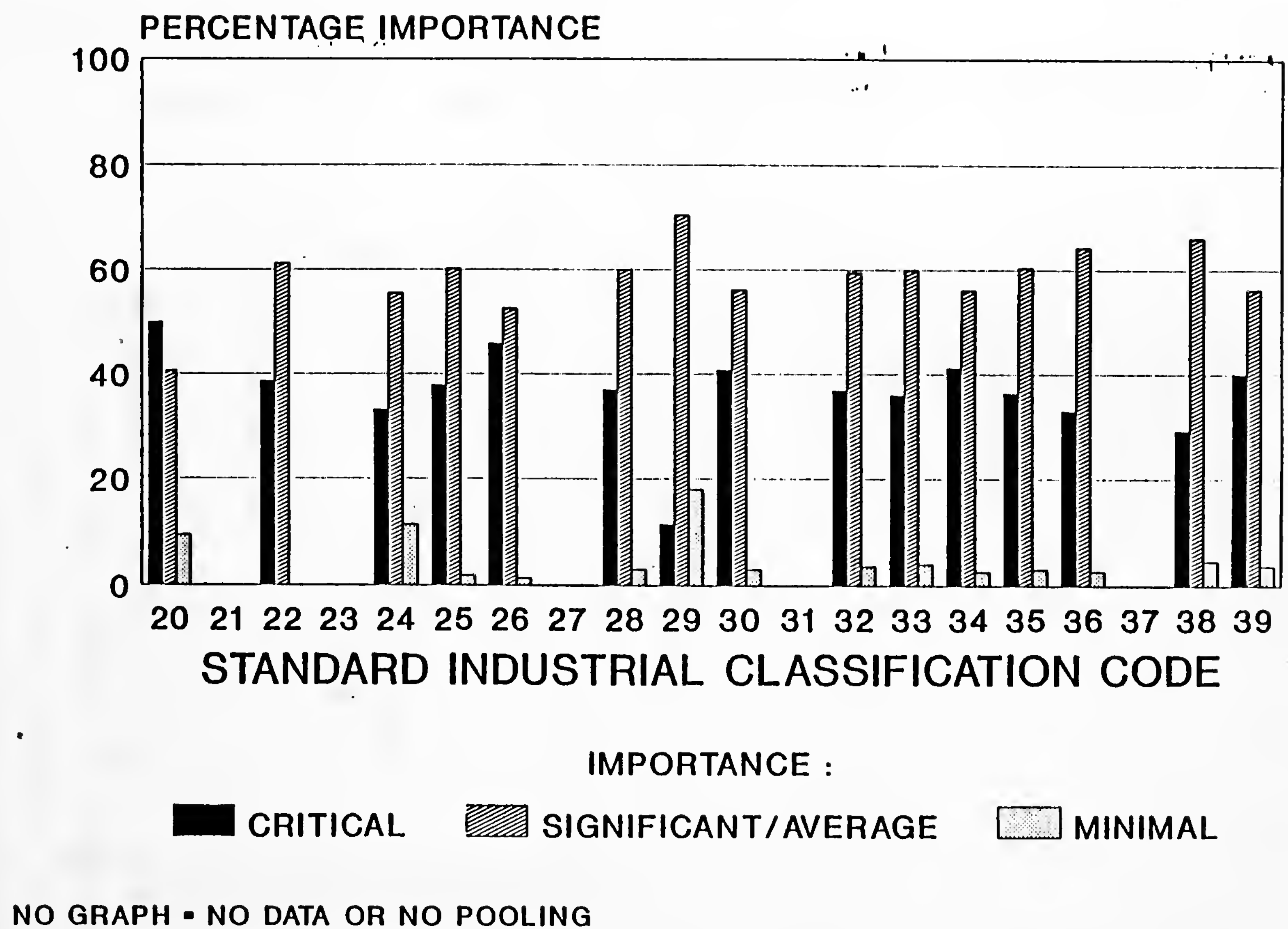


Figure 6.3 Percentage Importance of Highway Accessibility

and coal product manufacturing) had a highway accessibility importance rating of more than 18 percent in the minimal importance category. This can probably be attributed to the fact that railroad transportation was of higher importance to these industries than highways as such.

Scheduled Air Freight Service

In Figure 6.4 the importance of scheduled air freight service availability is shown. This variable had a critical importance to only about 10 percent of the industries in each SIC code in the sample. The number of industries in the significant to minimal importance category varies considerably across the spectrum of industries that were included in the sample. This indicates that various industries have different degrees of dependence on air freight service availability, probably because most industries depend on other modes of transportation to obtain its resources and distribute its products to markets. It can however be expected that this picture changed since the survey, especially with respect to high-technology industries that manufacture goods with a high value-volume ratio. Typical industries that fit this description are electrical machinery and equipment manufacturers (SIC code 36), as well as producers of instruments, and photographic and optical goods (SIC code 38).

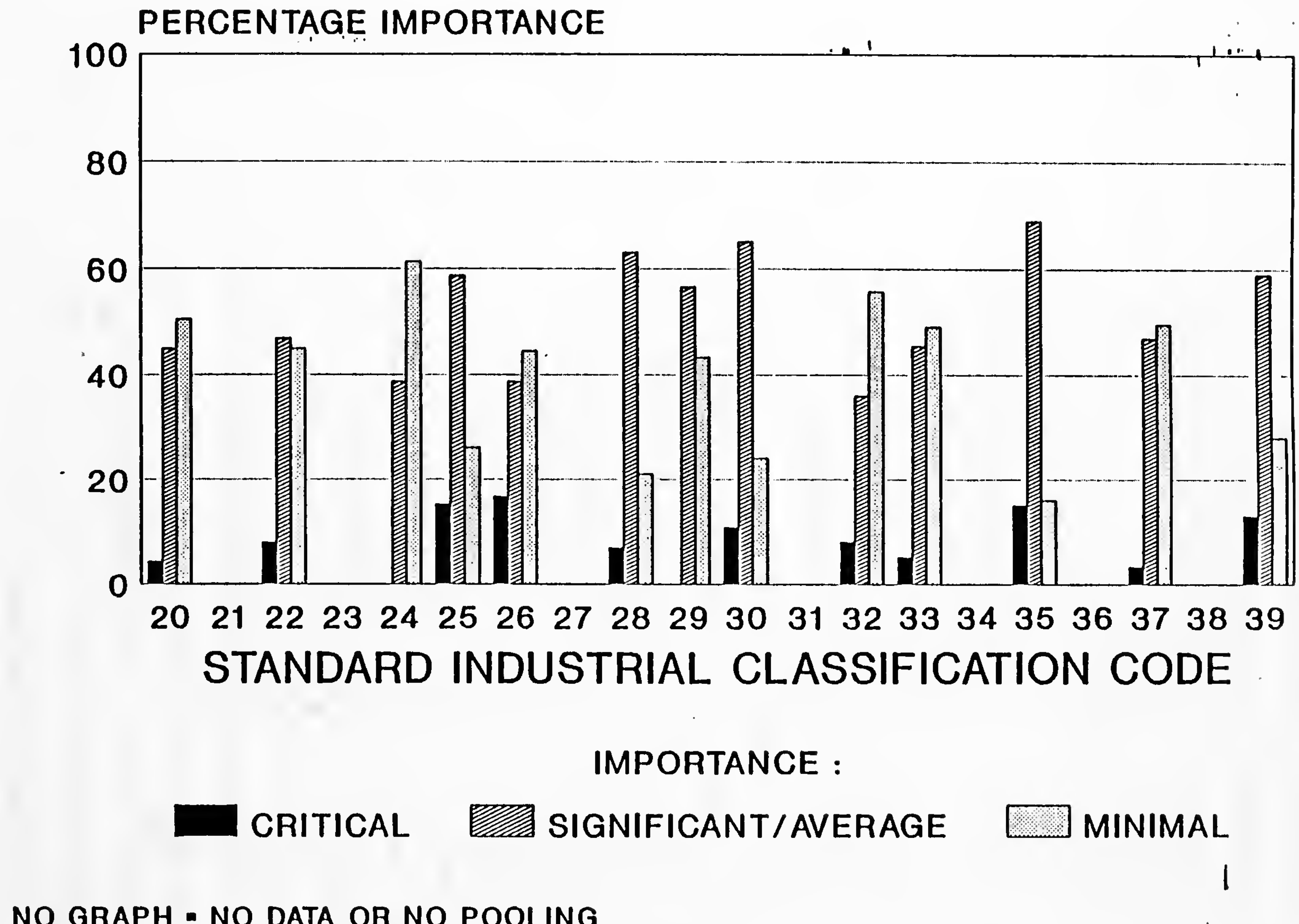


Figure 6.4 Percentage Importance of Scheduled Air Freight Service

Water Transportation

The substitution of water transportation with other modes of transportation that are more cost-effective and faster are clearly seen in Figure 6.5, which shows the importance of water transportation availability to industries when making locational decisions. None of the industry groups in the sample had a critical dependence on water transportation of more than 20 percent, and only SIC codes 24 and 29 indicated a significant to average importance of over 30 percent. These industry groups, respectively wood products and petroleum and coal product manufacturing, typically transport goods in high volume and can therefore use water transportation more effectively than other industries. Also, the import market for petroleum products dictate water transportation as the most viable mode of conveyance.

Contract Rail Service

Figure 6.6 shows how industries in the sample perceived the availability of rail service when deciding about a location. It is evident that industries had varying perceptions, visible not only in the graph, but also due to the fact that for 7 of the SIC groups data could not be pooled due to a high degree of variability in the data within SIC groups. Industries with SIC codes 24, 26, 29 and 32, which mostly represent high

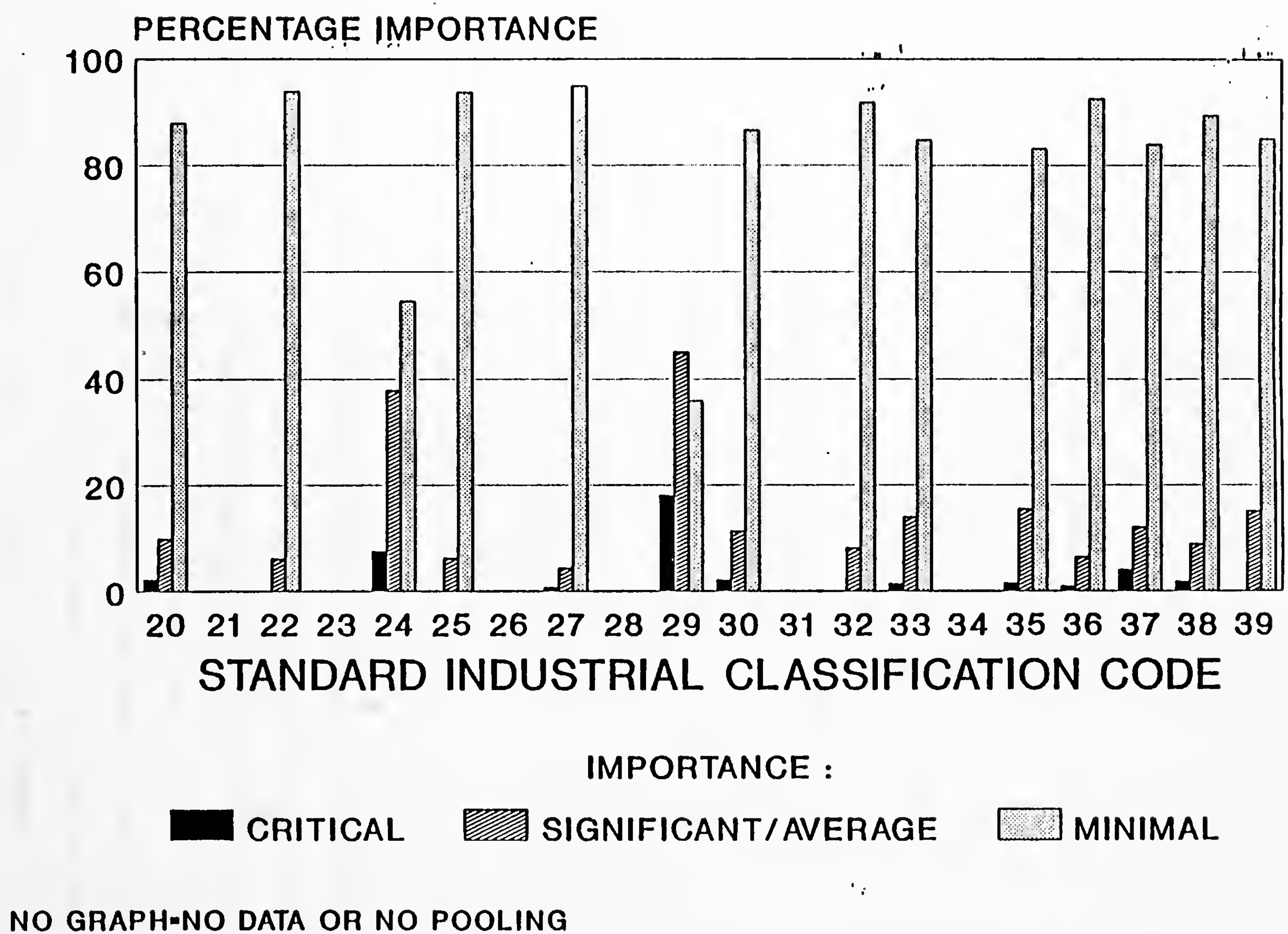


Figure 6.5 Percentage Importance of Water Transportation

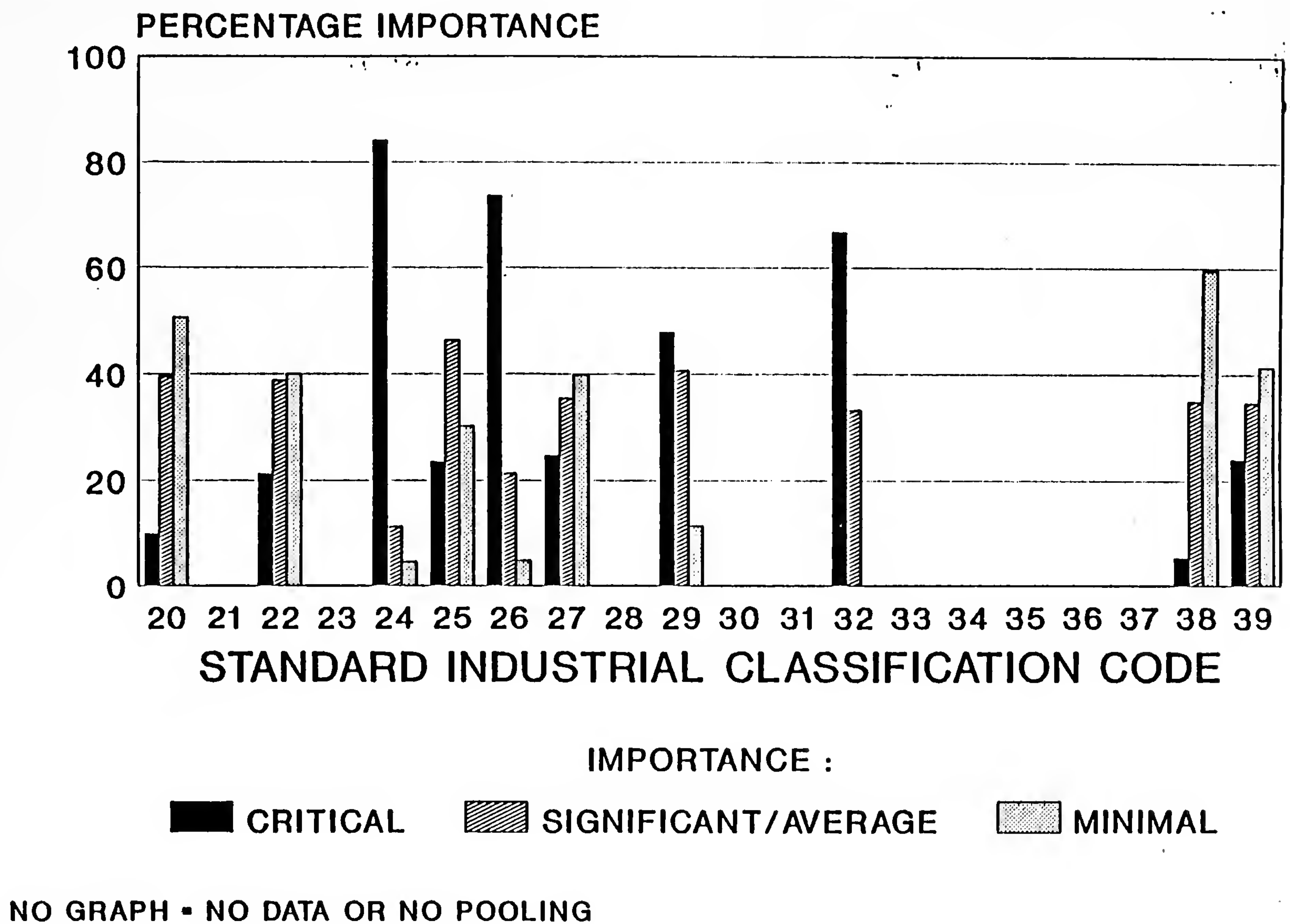


Figure 6.6 Percentage Importance of Contract Rail Service

volume goods, indicated a critical importance of rail service of 50 percent and higher.

Higher Educational Facilities

Figure 6.7 shows the importance of the presence of higher educational facilities in a location to industries in the sample. On average these facilities had a very low critical importance, a significant to average importance of about 50 percent, and a marginal importance of about 40 percent, thus indicating that this was not necessarily one of the key determinants of industrial location.

Tax Incentives

In Figure 6.8, the importance of tax incentives or tax holidays to industrialists are displayed. The graph shows a fairly uniform distribution of importance in the various classes for all the industries in the sample. Critical importance are rated around 10 percent, significant importance around 70 percent, and minimal importance around 20 percent in most of the cases. This conclusion is that this is a generally important location determinant, regardless of the type of industry.

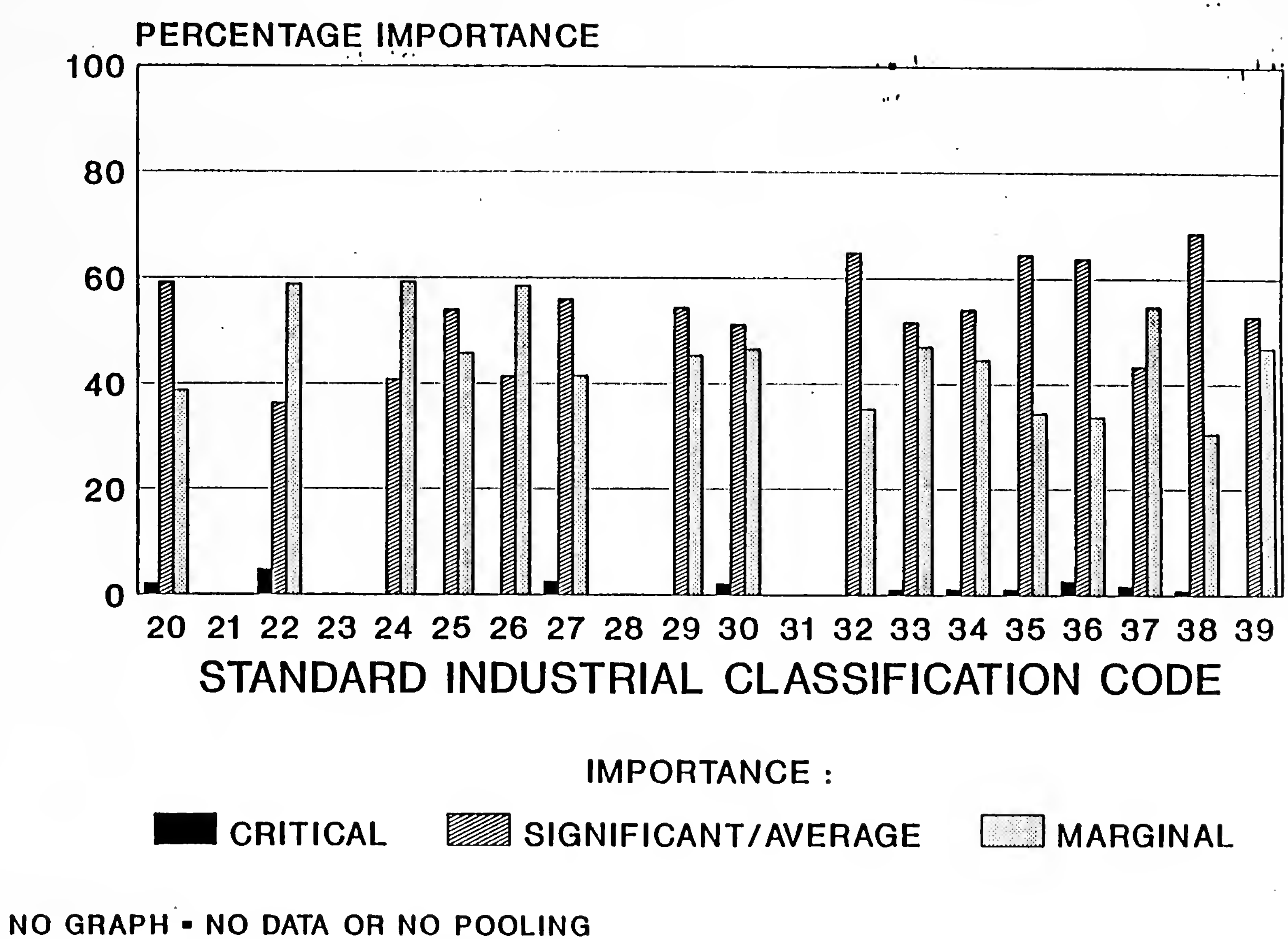
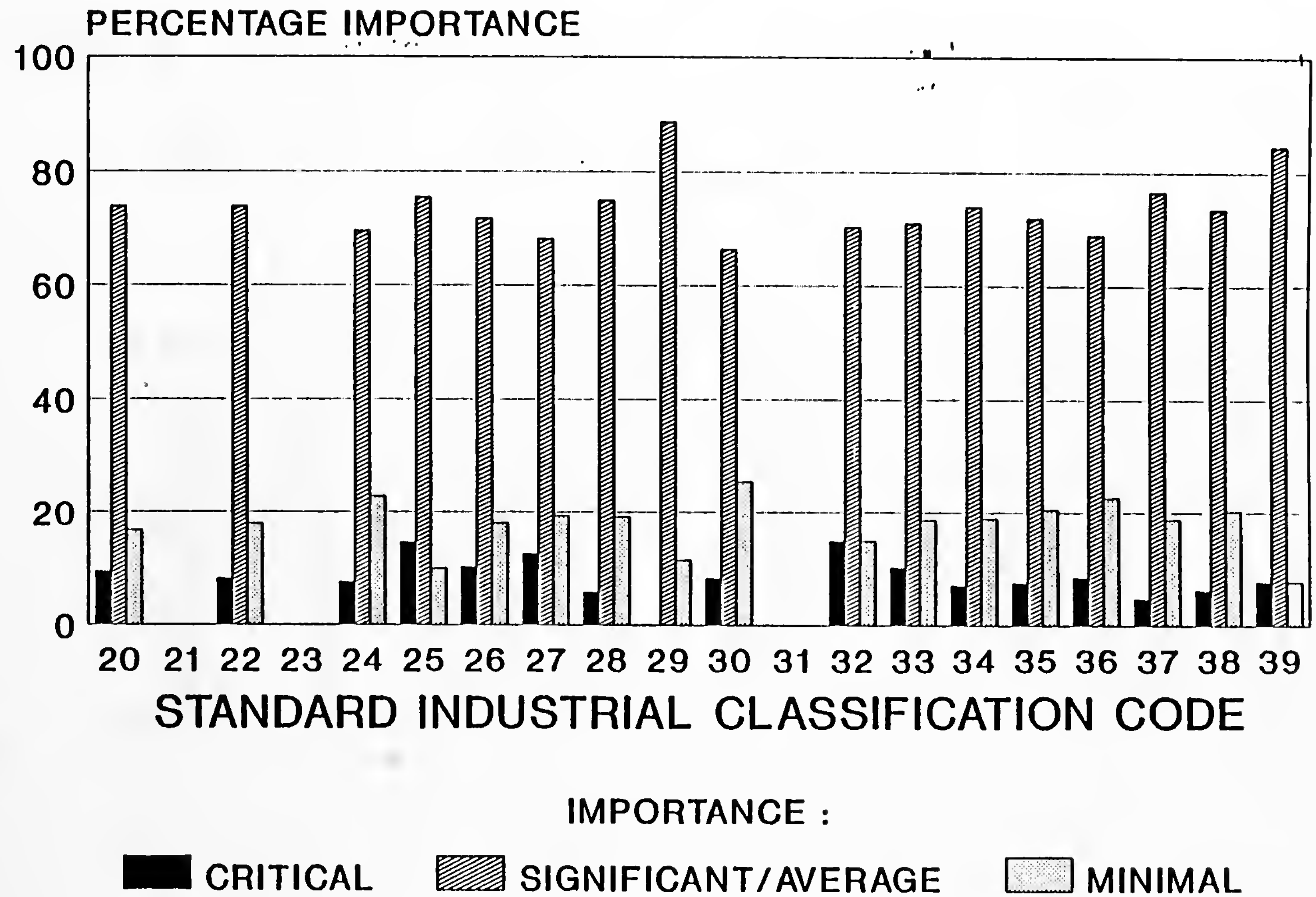


Figure 6.7 Percentage Importance of Higher Education Facilities



NO GRAPH = NO DATA OR NO POOLING

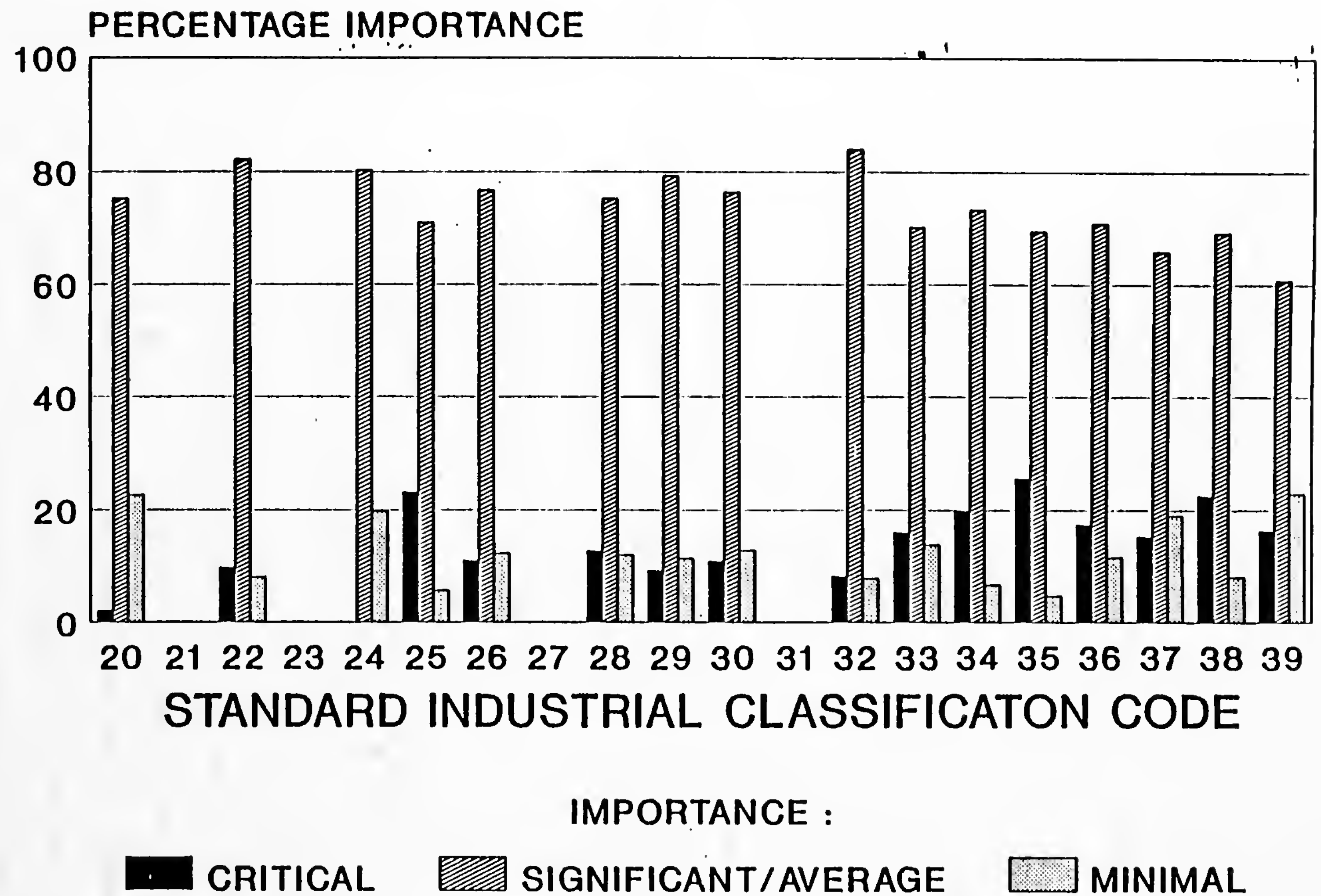
Figure 6.8 Percentage Importance of Tax Incentives

Pool of Trained Workers

In Figure 6.9, which shows how the availability of trained workers in an area affects industrial location decisions, a fair amount of variance between different industry types' dependence on this factor can be noted. The reason for this is probably that different industries rely to differing degrees on the availability of trained workers in a region. Some industries may not require as many skilled workers as others or are able to train unskilled workers more cost-effectively, while other more sophisticated industries such as machinery manufacturing industries (SIC code 38) rely heavily on workers with advanced and long-term training. In general, this determinant was of significant to average importance to about 70 percent of the industries in the sample.

Industrial Water Supply

The reliance of industries on the treated industrial water supply in a location is shown in Figure 6.10. This figure indicates a high degree of variability in various industries' treated water requirements, which can be related to the product and production processes of the different industries. The soft drink industry (SIC code 20) understandably has a very high critical dependence on this resource, as well as the textile mill industry (SIC code 22), while other industries in the sample had a water resource critical rating of around 20



NO GRAPH = NO DATA OR NO POOLING

Figure 6.9 Percentage Importance of Trained Worker Availability

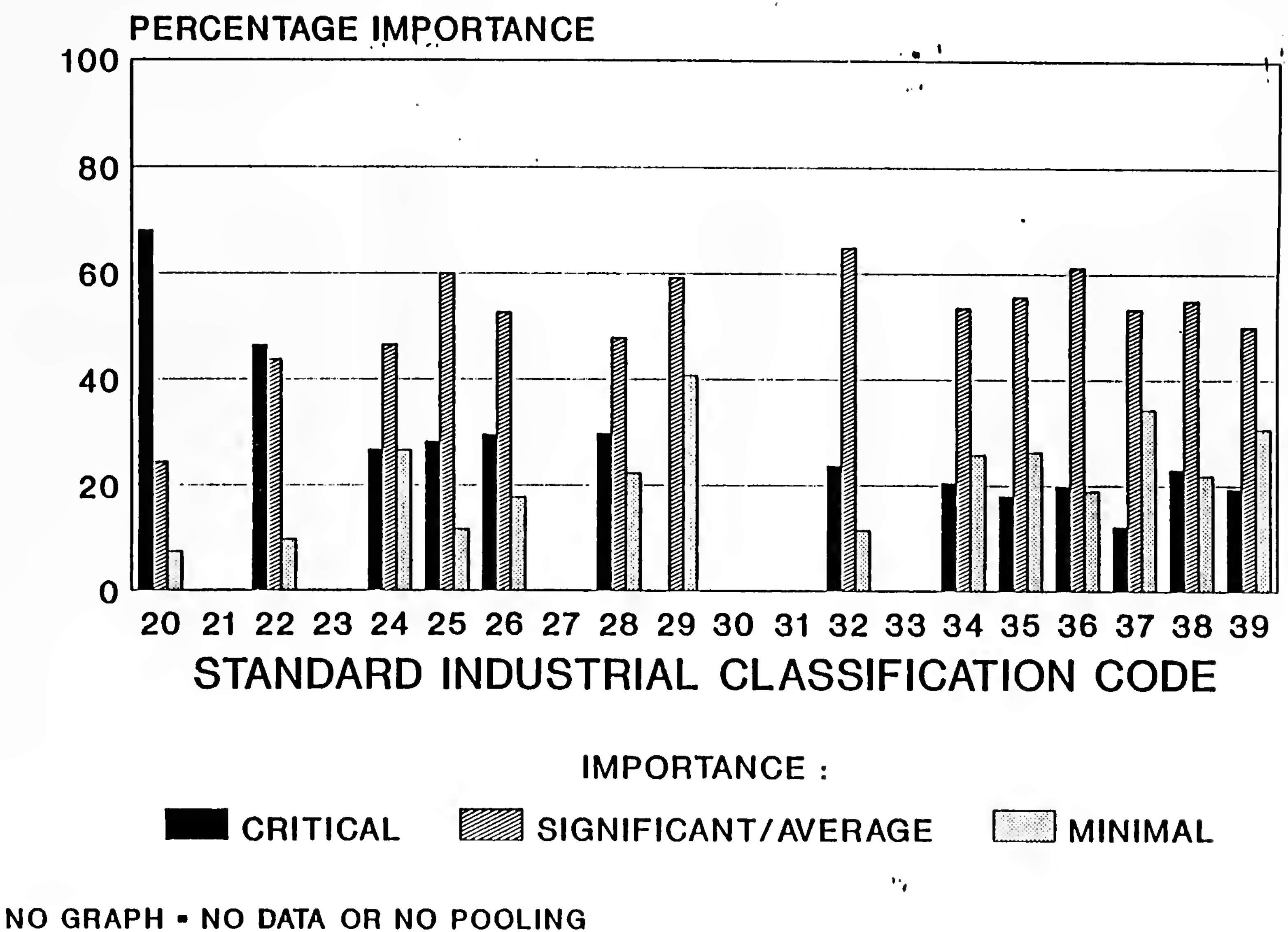


Figure 6.10 Percentage Importance of Industrial Water Supply

percent. Significant to average importance rated on average 50 percent among all the industries, indicating that this is a relatively important determinant of industrial location.

Combination of Results

In conclusion, a weighted index of each of the ten determinants that were analyzed was computed to obtain an overall idea of the importance of each of the indicators. In weighing the results from the study, the following equation was used :

$$OI_i = [(3*\sum_{j=1}^{J} CR_{ij}) + (2*\sum_{j=1}^{J} SG_{ij}) + (1*\sum_{j=1}^{J} MIN_{ij})]/SIC_i$$

where OI_i = overall importance of indicator i;

CR_{ij} = critical importance of indicator i to SIC group j;

SG_{ij} = significant to average importance of indicator i to SIC group j;

MIN_{ij} = minimal importance of indicator i to SIC group j;

SIC_i = number of SIC groups under indicator i for which data could be pooled.

Figure 6.11 shows the overall importance of each indicator as derived from the equation above. It is evident that highway

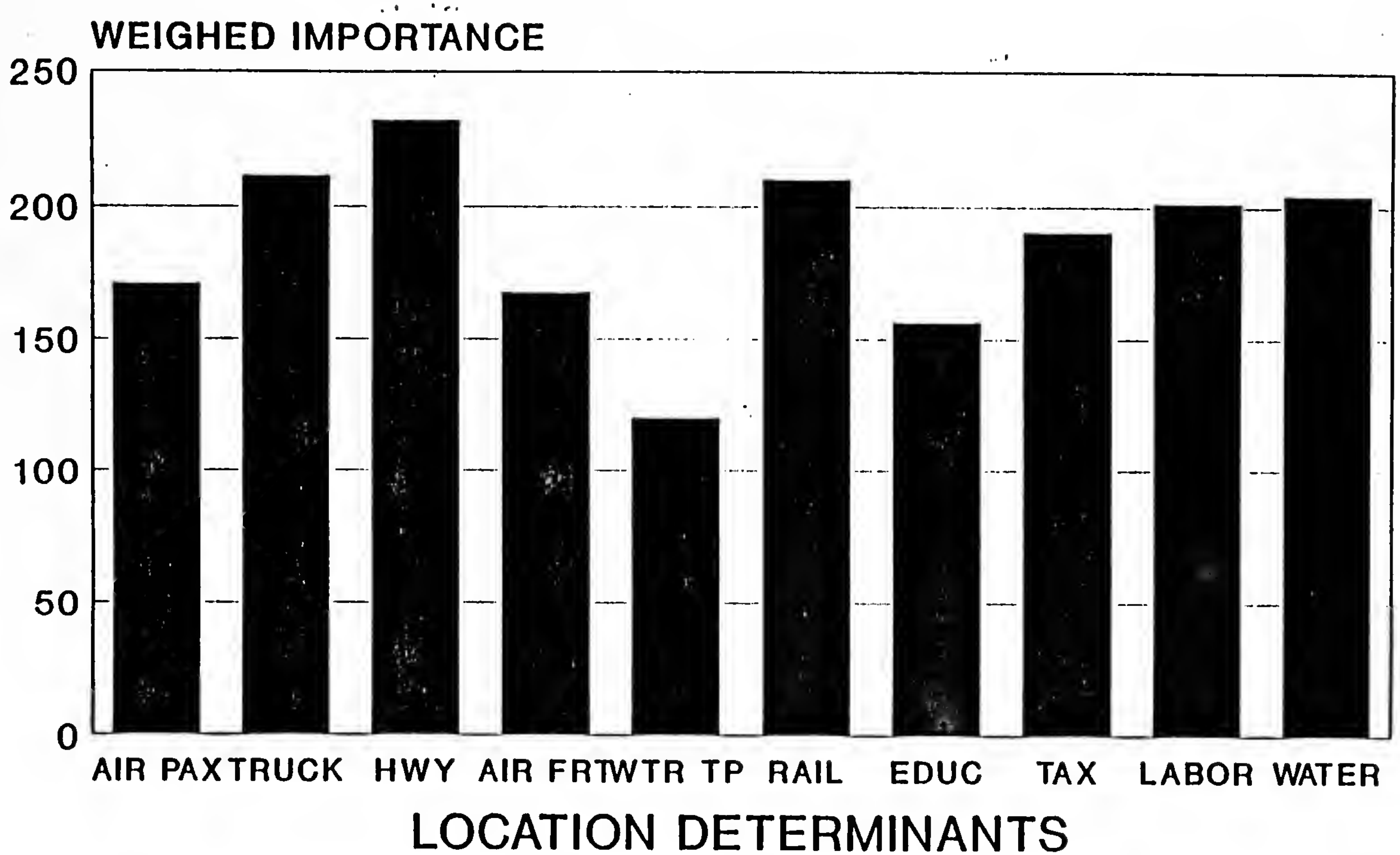


Figure 6.11 Weighted Importance of Indicators

access had the highest weighted rating of all 10 indicators included in this analysis, with truck and rail transportation availability of more or less equal importance as the second most prominent industry location determinant in the sample. It is important to note here that since the trucking sector has expanded tremendously since the time that the data collection for this study was done, trucking is currently probably a stronger determinant of industry location than railway availability.

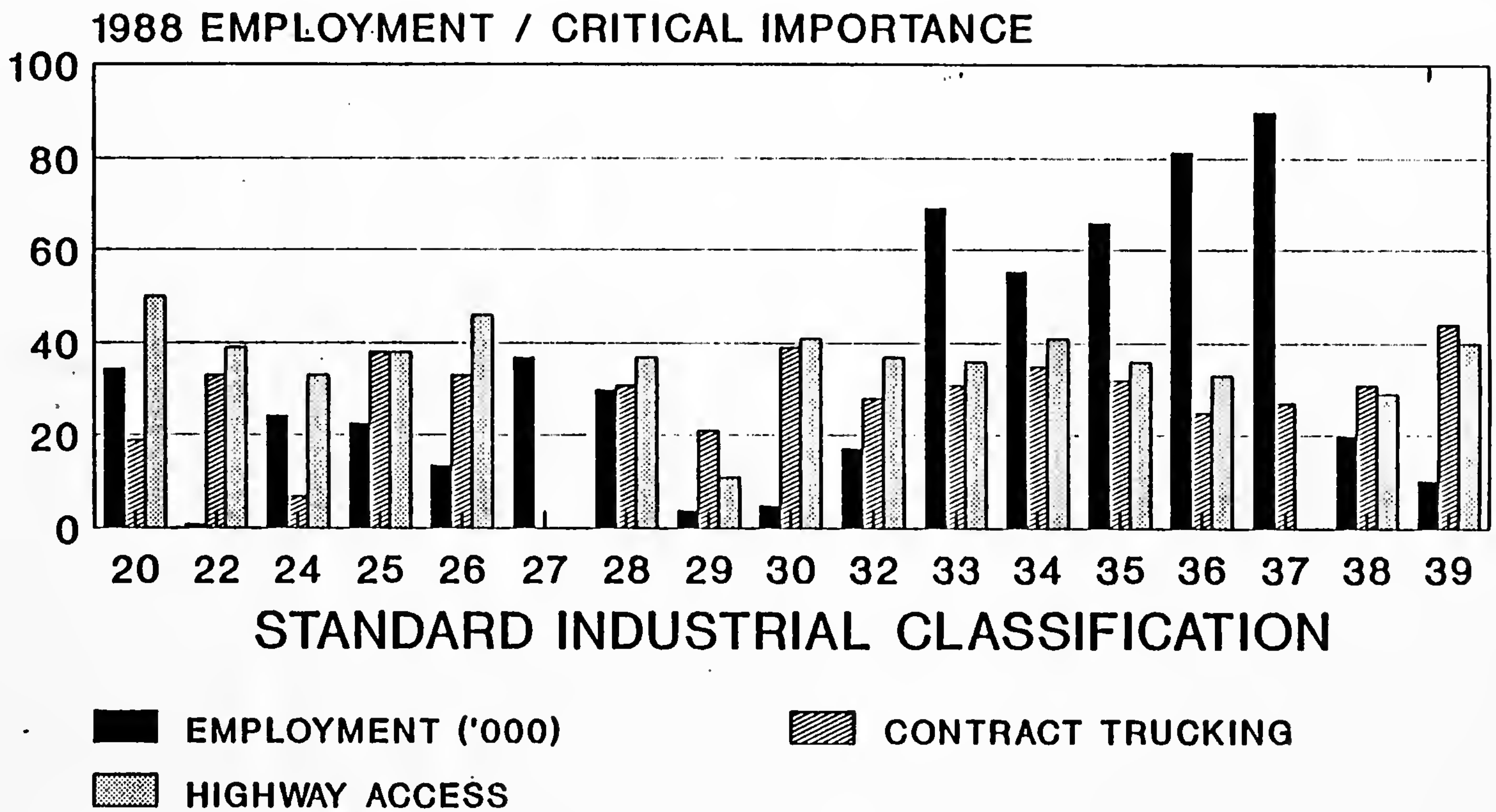
Air passenger service and air freight transportation were of about equal importance in the sample, but overall of less importance than water and labor availability, as well as the presence of tax incentives. Educational facilities had the second lowest ranking, and water transportation was the least significant of all indicators. The reason for this is probably because only a limited number of industries rated this mode of transportation as important to their operations.

Importance of Findings to Industries in Indiana

The final part of this analysis was concerned with comparing current employment figures in Indiana with the importance of the highway indicators that were included in the study, namely highway access and contract trucking availability.

Figure 6.12 shows the 1988 manufacturing employment figures for individual SIC codes in the state of Indiana in thousands of employees, together with the percentage of industries in the national survey that indicated critical dependence on the two highway determinants as mentioned above. In general, the critical importance of both indicators is between 20 and 40 percent. Figure 6.13 shows the Indiana employment in 1988 and the average to significant importance of the transportation indicators. In this case, the importance of trucking and highway access was on average between 40 and 70 percent.

From neither of these figures is it graphically evident that employment levels between different SIC codes in the manufacturing sector in Indiana varied according to the importance of trucking and highway access in 1988. This is probably because many other factors are important for the current size of labor forces in specific industry sectors. It also indicates that more effort could be made in Indiana to attract industries which are highway transportation dependent, due to the relatively good availability of highway infrastructure in the state.



NO PLOT = NO POOLING POSSIBLE
1988 EMPLOYMENT IN THOUSANDS
TRANSPORTATION IMPORTANCE IN PERCENT

Figure 6.12 Indiana Industries and Critical Importance of Transportation

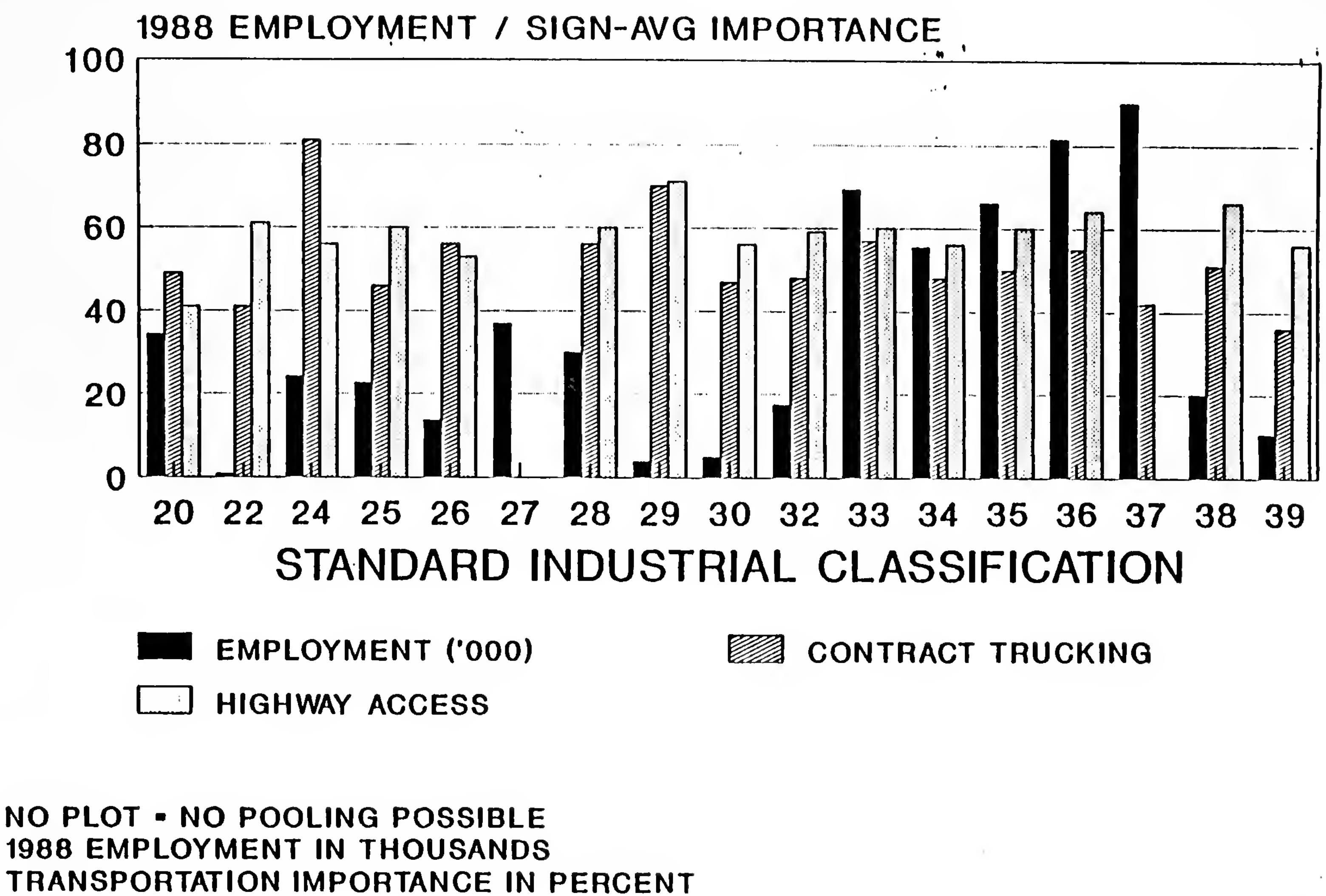


Figure 6.13 Indiana Industries and Significant to Average Importance of Transportation

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to investigate the relationship between highway infrastructure and regional economic development in the state of Indiana. In order to examine this complicated association effectively, the study was divided in several sections in which various approaches at differing levels of aggregation were undertaken.

Highways are intrinsically involved in the economy. In order to prove this, one only needs to contemplate the US without any interstate highways to accommodate flow of freight and passengers across the country, four-lane highways that increase accessibility through different parts of a state, and other highways, especially in cities and towns, that provide internal access and circulation.

In 1991, Indiana is a state that compares well to the Midwest region, and also the country, with regard to the extent of its highway network. A total of seven interstate highways converge on Indianapolis from virtually all directions. Two major interstates, one in the North and the other in the South, provides east-west traffic flow. In addition, several four-

lane highways exist that provide access to other parts of the state, and with the rest of the network comprise of over 90,000 miles of roads in Indiana. This system is, however, in constant need of maintenance and repair. Also, some links in the network are still needed, such as the Southwest Indiana corridor connecting Indianapolis to Evansville, and the Hoosier Heartland Corridor, connecting Lafayette to Fort Wayne with an improved roadway.

Limited funds, in view of increasing needs, do however necessitate careful planning in allocating expenditures for highway construction and maintenance. In this regard, the role that highways can play in the economic growth of a region has gained importance in recent years. Of increasing importance is how a state's infrastructure, and specifically its highways that constitute the major portion of infrastructure investment, can be used to promote economic development.

Before the importance of highways in economic development is assumed, some issues need to be addressed. Firstly, although highways were found to be significantly related to economic growth in this and other studies in the literature, it does not necessarily imply that the marginal impact of highway construction will stay as important should a highway system be continuously extended. After a system has reached a certain level of coverage, marginal benefit derived from new

construction starts to decline. Also, by extending a highway network too exhaustive, maintenance and reconstruction could become excessive and indeed a liability to a state.

Another issue is the importance of specific institutions to the economic well-being of a region. There is little doubt as to the importance of the existence of specific entities, such as universities, military bases, and large industrial complexes to the export base of a region. While highways may play a role in attracting and retaining these economic entities, especially manufacturing industries, these institutions are often subject to changes outside the local area, such as federal policy decisions and national or international economic implications. In that sense, highway infrastructure's role becomes marginal.

Some specific conclusions and consequently recommendations can be made concerning the regression models that were developed in this study. This study highlighted the fact that Indiana's highway expenditures per mile over the last decade were much lower than other states in the region on the average state in the U.S. While this is somewhat subject to interpretation, this matter should be attended to.

Although highway pavement condition was not found to be consistently significantly associated with economic development, this does not imply that existing highways should

be allowed to deteriorate indiscriminately. The data and short time period of the study had some limitations associated with them, but it can also be argued that there is a lag effect involved between the deterioration of highways and economic growth. While it may take several years before the local economy will reflect poor road conditions, the opposite will also be true, namely that concerted effort and excessive expenditures on highway repair may be needed to revive a region economically. It is recommended that proposed roadway management programs be implemented and maintained, to prevent deterioration of the main highways in the state.

The total highway mileage was found to be significantly associated with economic development. Multi-lane highways were however found to have an association of between 5 and 10 times that of the total highway system. Consideration should therefore be given on identifying strategic highways throughout the state, and targeting them for increased maintenance and facility improvement investments. Consideration should also be given to constructing the missing links in the main network, namely the Southwest Indiana Corridor and the Hoosier Heartland Corridor. Greater emphasis should be placed on project priorities, in the light of limited funds for increasing needs. Some efforts to reduce the total road network should be made, such as the abandonment of low-volume county roads.

Highway expenditures were not identified as a good determinant of economic growth. Although this could be attributed to the limited time period of the study and possibly unreliable data, it could also indicate ineffective expenditure of highway funds.

Several models were developed in this study that can be used to estimate the economic development impacts of constructing new two-lane highways, upgrading two-lane roads to four-lane highways, and the construction of new four-lane highways. These models should be used with utmost care, keeping in mind the limitations of the methodology, the fact that the models were based on data for a relatively short time period, and subject to a specific time-frame in terms of economic changes in the state's history. The models only provide estimates based on previous trends, that may not necessarily continue in future years.

Concerning the analyses of four-lane corridors in Indiana over the past 40 years, some specific conclusions can also be made. Some evidence was found to indicate that the corridor as a whole through which a four-lane highway is built showed higher economic growth than the state over both the construction period and beyond. Highway construction appears to benefit the region, and not necessarily only the counties through which highway construction is undertaken (primary counties). Reasons for this are that some primary counties are too small to

provide construction resources which are drawn from adjacent larger counties; also, some projects are so small that only a marginal economic impact is made. Evidence also suggests that individual counties through which four-lane highways are built have higher economic growth over the long term than adjacent counties or the state on the average. However, because of large variances in the data, this evidence could not be statistically confirmed with high levels of confidence.

This study as a whole did not address the issue of through-truck traffic, and the impact that Indiana's highways may have on improving coast-to-coast accessibility in the US. It could be argued, however, that some of the benefits realized from this would trickle down to local economies, and thus may have been captured to some extent in the study. Also, due to limitations in the database, the impact of high quality two-lane or super-two lane highways could not be addressed, as well as the impact of upgrading existing four-lane highways to access-controlled freeways. As a result from these limitations, the potential economic development benefits from super-two roadways are overloaded, as well as those associated with the upgrading of existing multi-lane facilities to freeway standards.

Several factors were identified that had significant association with economic development in Indiana between 1980 and 1988. Two of the most consistent were factors that could

be influenced at the local level, namely the percentage of college graduates in a county, and the average property tax rate. Local authorities in general should be alerted of the perceived importance of these factors in the Indiana economy over the past decade.

This study's results were consistent with other studies, namely that highways play a definite role in the economy of a state, albeit in the imperative presence of other important factors. Careful planning, construction and maintenance of Indiana's highway infrastructure stock will ensure that the state sustain and improve its economic position in the region and in the United States.

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APPENDIX

SIC GROUP 1 : SIC CODES 1,2,7,8,9 : AGRICULTURE, FORESTRY AND FISHING

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
1980 MILES	NONE	88 ***				***					#	#	0.57
	MAN+SVC					***				*		**	0.62
1980 >2LN	NONE	531 ***				***				**	#	#	0.47
MILES	MAN+SVC	(494)**	*		-*	***				*		***	0.65

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	NONE	1 ***				***	*		-*	#	#	0.63
	MFG + SVC					***			-*		**	0.68
1980 >2LN	NONE	9 ***				**				#	#	0.46
MILES	MAN+SVC	(5)***	*			***					***	0.69

SIC GROUP 2 : SIC CODES 12,13,14 : MINING

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
1980 MILES	NONE								*	-***	#	#	0.09
	MAN+SVC								*	-***			0.08
1980 >2LN	NONE								**	-**	#	#	0.10
MILES	MAN+SVC								**	-**			0.08

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	NONE									#	#	0.00
	MFG + SVC											-0.02
1980 >2LN	NONE								**	#	#	0.02
MILES	MAN+SVC	(18) *	**						**			0.01

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 3 : 15,17 : GENERAL AND SPECIAL CONTRACTING

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
1980 MILES	NONE	800 ***		-*		***	***	**	-**		#	#	0.80
	MAN+SVC				-***	***	**		-**	-**		***	0.92
1980 >2LN MILES	NONE	6,644 ***	-***			***				-*	#	#	0.73
	MAN+SVC				-**	***	*		-**	-**		***	0.92

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	NONE	14 ***		-**		***	***	*	-***	#	#	0.75
	MFG + SVC		-*	-**	-**	***	**		-***		***	0.84
1980 >2LN MILES	NONE	111 ***	-***	-***		***	**		-**	#	#	0.65
	MAN+SVC			-*	-**	***	**		-***		***	0.84

SIC GROUP 4 : 16 HEAVY CONSTRUCTION

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
1980 MILES	NONE	(41) *	-**		-**				-*	-***	#	#	0.30
	MAN+SVC		-*		-**					-***	-*		0.32
1980 >2LN MILES	NONE	(555)***			-***					-***	#	#	0.34
	MAN+SVC	(744)**			-***					-***	-**	*	0.34

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	NONE	(2)**	-**			-*			-***	#	#	0.32
	MFG + SVC		-**		-*				-*	-***		0.44
1980 >2LN MILES	NONE	(27)***	-*		-**				-***	#	#	0.36
	MAN+SVC	(29) *			-**					-***	***	0.46

NOTES :

\# = VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 5 : SIC CODE 20 : FOOD PRODUCTS

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC	142 **									**	-***	0.57
1980>2LN MI	MAN+SVC										**	-***	0.55

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC	3 *									-***	0.61
1980>2LN MI	MFG+SVC										-***	0.59

SIC GROUP 6 : SIC CODES 22,23 : TEXTILE PRODUCTS AND CLOTHING

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC								-**				0.08
1980>2LN MI	MAN+SVC								-*				0.07

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC								-**			0.10
1980>2LN MI	MFG+SVC								-*		*	0.08

NOTES :
\# = VARIABLE NOT INCLUDED IN REGRESSION
COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN
SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :
*** = 1% OR LESS
** = 5% OR LESS
* = 10% OR LESS

SIC GROUP 7 : SIC CODE 24 : LUMBER AND WOOD PRODUCTS

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC								-***		***	-***	0.18
1980>2LN MI	MAN+SVC								-***		***	-***	0.20

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC								-***	***	-***	0.18
1980>2LN MI	MFG+SVC								-***	***	-***	0.19

SIC GROUP 8 : SIC CODE 25 : FURNITURE MANUFACTURING

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC								-***		***	-***	0.18
1980>2LN MI	MAN+SVC								-***		***	-***	0.19

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC		-*						-***	***	-***	0.16
1980>2LN MI	MFG+SVC		-*						-***	***	-**	0.17

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 9 : SIC CODE 26 : PAPER PRODUCTS

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC					*	*			-**			0.02
1980>2LN MI	MAN+SVC					*				-**			0.02

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC											-0.04
1980>2LN MI	MFG+SVC											-0.04

SIC GROUP 10 : SIC CODES 27 : PRINTING AND PUBLISHING

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC									***	-**	***	0.49
1980>2LN MI	MAN+SVC	-753 *								***	-***	***	0.51

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC								-**	-***	***	0.68
1980>2LN MI	MFG+SVC								-*	-***	***	0.68

NOTES :
= VARIABLE NOT INCLUDED IN REGRESSION
COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN
SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :
*** = 1% OR LESS
** = 5% OR LESS
* = 10% OR LESS

SIC GROUP 11 : SIC CODE 28 : CHEMICAL PRODUCTS

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC			**					-*	*	-***	***	0.40
1980>2LN MI	MAN+SVC			***	-*					**	-***	***	0.40

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC	5 *		**					-**	-***	***	0.58
1980>2LN MI	MFG+SVC			**					-**	-***	***	0.56

SIC GROUP 12 : SIC CODES 29,30 : PETRO, COAL, PLASTIC, RUBBER PRODUCTS

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC				-***				-**		**	-*	0.18
1980>2LN MI	MAN+SVC	-1589 **			-***						**		0.22

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC				-***		-**		-**			0.17
1980>2LN MI	MFG+SVC	(34)**			-***		-**					0.21

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 13 : SIC CODE 31 : LEATHER PRODUCTS

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC					#							0.03
1980>2LN MI	MAN+SVC					#							0.05

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC				-#							0.07
1980>2LN MI	MFG+SVC	-2.20 **			-**	#						0.13

SIC GROUP 14 : SIC CODES 32 : STONE, CLAY AND GLASS PRODUCTS

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC												-0.06
1980>2LN MI	MAN+SVC												-0.04

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC											-0.08
1980>2LN MI	MFG+SVC											-0.07

NOTES :
= VARIABLE NOT INCLUDED IN REGRESSION
COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN
SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :
*** = 1% OR LESS
** = 5% OR LESS
* = 10% OR LESS

SIC GROUP 15 : SIC CODE 33 : PRIMARY METAL INDUSTRIES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC	1201 *							-***		-***	***	0.63
1980>2LN MI	MAN+SVC	-7138 *							-***	*	-***	***	0.63

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC	52 **							-***	-***	***	0.62
1980>2LN MI	MFG+SVC								-**	-***	***	0.61

SIC GROUP 16 : SIC CODE 34 : FABRICATED METAL PRODUCTS

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC								-***				0.24
1980>2LN MI	MAN+SVC	-1536 *			-#				-***				0.27

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC	7 ***							-**	-**		0.22
1980>2LN MI	MFG+SVC									-***	***	0.21

NOTES :

\# = VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 17 : SIC CODE 35 : INDUSTRIAL MACHINERY

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC			-*					-**				0.11
1980>2LN MI	MAN+SVC			-*					-**				0.11

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC			-**	#				-***			0.15
1980>2LN MI	MFG+SVC			-**	#				-***			0.15

SIC GROUP 18 : SIC CODE 36 : ELECTRIC AND ELECTRONIC EQUIPMENT

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC	-512 **	*		-***	**			**		***	-***	0.86
1980>2LN MI	MAN+SVC				-**	**			**	-**	***	-***	0.85

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC	(7) *				*	-**		**	***	-***	0.89
1980>2LN MI	MFG+SVC					**			**	***	-***	0.89

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 19 : SIC CODE 37 : TRANSPORTATION EQUIPMENT

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC								-***		***	-***	0.39
1980>2LN MI	MAN+SVC								-***		***	-***	0.38

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC					*			-***	***	-***	0.44
1980>2LN MI	MFG+SVC					*			-***	***	-***	0.43

SIC GROUP 20 : SIC CODES 38,39 : INSTRUMENTS AND MISCELANEOUS MANUFACTURING

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SRVEMP	R**2
1980 MILES	MAN+SVC	-340 **					-*					**	0.15
1980>2LN MI	MAN+SVC	-1998 **										**	0.14

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	MANEMP	SVCEMP	R**2
1980 MILES	MFG+SVC	(9)**									***	0.24
1980>2LN MI	MFG+SVC	(67)-**									***	0.24

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 21 : SIC CODES 41,42,44,45,47 : TRUCKING, WAREHOUSING, TRANSPORTATION

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP
POOR	MFG + SVC		#					*				***	***
1980 MILES	*	#	679 ***					*	*			#	#
	MAN+SVC	#	(135)**									***	***
1980 >2LN	*	#	5,785 ***	-***								#	#
MILES	MAN+SVC	#						*				***	***

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	10 ***					**			#	#	0.65
	MAN+SVC	#				-*					**	***	0.83
1980 >2LN	*	#	81 ***	-**							#	#	0.62
MILES	MAN+SVC	#						*		-*	***	***	0.83

SIC GROUP 22 : SIC CODE 48 : COMMUNICATIONS

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP
POOR	MFG + SVC		#			-**	***	*					
1980 MILES	*	#	(111)***			-**	***					#	#
	MAN+SVC	#				-*	***	*				-***	
1980 >2LN	*	#	(1,118)***			-***	***					#	#
MILES	MAN+SVC	#	(654) *			-**	***						

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#				-*	***	**			#	#	0.18
	MAN+SVC	#				-*	***	*					0.19
1980 >2LN	*	#				-*	***	*			#	#	0.20
MILES	MAN+SVC	#	(27) *			-**	***					*	0.22

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 23 : SIC CODE 49 : ELECTRIC, GAS AND SANITARY SERVICES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SVCEMP
POOR	MFG + SVC		#		*		-*			-**	*		
1980 MILES	*	#			*		-**			-*	**	#	#
	MAN+SVC	#			*		-*			-**	*		
1980 >2LN MILES	*	#	200 *		*		-**			-*	**	#	#
	MAN+SVC	#			*		-*			-**			

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	3.7 ***							-***	#	#	0.37
	MAN+SVC	#								-***		***	0.44
1980 >2LN MILES	*	#	34.0 ***	-***		*				-***	#	#	0.41
	MAN+SVC	#	15.0 *	-*		*				-***		**	0.46

SIC GROUP 24 : SIC CODE 50 : WHOLESALE DURABLE TRADE

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SVCEMP
POOR	MFG + SVC		#			-**	**	*		-**		-***	
1980 MILES	*	#	362 ***				*	*				#	#
	MAN+SVC	#				-**	***	*		-**		***	
1980 >2LN MILES	*	#	2,732 ***	-*								#	#
	MAN+SVC	#				-**	***	*		-**		***	

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	16 ***				***	**		-**	#	#	0.68
	MAN+SVC	#					***	**		-***	**	**	0.77
1980 >2LN MILES	*	#	124 ***	-***			*				#	#	0.57
	MAN+SVC	#					***	**		-***	**	***	0.77

NOTES :

\# = VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 25 : SIC CODE 51 : WHOLESALE NON-DURABLE TRADE

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MF6 + SVC		#							-*			***	0.43
1980 MILES	*	#	99 ***	-*	-*					-**		#	#	0.33
	MAN+SVC	#			-*								***	0.44
1980 >2LN	*	#	687 ***	-***	-*					-*		#	#	0.29
MILES	MAN+SVC	#	(723)**		-**							-*	***	0.46

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	3 ***	-*	-*		**			-***	#	#	0.43
	MAN+SVC	#					*			-***	-**	***	0.54
1980 >2LN	*	#	25 ***	-***	-*		**			-***	#	#	0.38
MILES	MAN+SVC	#				-*	**			-**	-**	***	0.56

SIC GROUP 26 : SIC CODE 52 : BUIDING MATERIALS AND GARDEN SUPPLIES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MF6 + SVC		#				*			-*			***	0.90
1980 MILES	*	#	185 ***				*	**	**	-*		#	#	0.75
	MAN+SVC	#					*			-*			***	0.90
1980 >2LN	*	#	1,486 ***	-***								#	#	0.67
MILES	MAN+SVC	#					*						***	0.90

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	3 ***				*	**	*	-***	#	#	0.66
	MAN+SVC	#								-**	-***	***	0.81
1980 >2LN	*	#	21 ***	-***						-**	#	#	0.56
MILES	MAN+SVC	#						*		-**	-***	***	0.81

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 27 : SIC CODE 53 : GENERAL MERCHANDISE STORES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#			-**	***			-**	*	-***	***	0.49
1980 MILES	*	#	(61)**			-**	***			-***	*	#	#	0.38
	MAN+SVC	#				-**	***			-***		-***		0.49
1980 >2LN	*	#	(515)**			-**	***			-***	*	#	#	0.38
MILES	MAN+SVC	#				-**	***			-**	*	-***	*	0.48

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	-1.2 ***			-**	***			-***	#	#	0.61
	MAN+SVC	#				-**	***			-***	-***		0.72
1980 >2LN	*	#	-9.4 ***			-**	***			-***	#	#	0.59
MILES	MAN+SVC	#				-**	***			-***	-***		0.71

SIC GROUP 28 : SIC CODE 54 : FOOD STORES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#				***			-***			***	0.64
1980 MILES	*	#	188 ***				***			-***		#	#	0.58
	MAN+SVC	#					***			-***			***	0.64
1980 >2LN	*	#	1,447 ***	-***			***			-***		#	#	0.52
MILES	MAN+SVC	#					***			-***			***	0.64

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	-2.9 ***	-*			**			-***	#	#	0.59
	MAN+SVC	#		-**			**			-***	-***		0.72
1980 >2LN	*	#	-26.0 ***			-*	**			-***	#	#	0.59
MILES	MAN+SVC	#				-*	**			-**	-***		0.73

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 29 : SIC CODES 55,75 : AUTO DEALERS, REPAIR AND PARKING

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#			-***	*			-*		**	***	0.94
1980 MILES	*	#	469 ***				*		**			#	#	0.80
	MAN+SVC	#				-***	-*			-*		**	***	0.94
1980 >2LN	*	#	3,753 ***	-***								#	#	0.74
MILES	MAN+SVC	#				-**	*			-*		**	***	0.94

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	10 ***				***	***	**	-***	#	#	0.76
	MAN+SVC	#				-*				-***		***	0.88
1980 >2LN	*	#	79 ***	-***		*	**			-*	#	#	0.67
MILES	MAN+SVC	#				-**				-***		***	0.88

SIC GROUP 30 : SIC CODE 56 : APPAREL AND ACCESSORY STORES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#		*							-***	***	0.56
1980 MILES	*	#	191 ***							-**		#	#	0.47
	MAN+SVC	#										-***	***	0.57
1980 >2LN	*	#	1,613 ***	-**						-*		#	#	0.45
MILES	MAN+SVC	#										-***	***	0.56

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	2 ***							-***	#	#	0.41
	MAN+SVC	#	2 ***								-***	***	0.53
1980 >2LN	*	#	17 ***	-***						-***	#	#	0.38
MILES	MAN+SVC	#									-***	***	0.50

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 31 : SIC CODE 58 : EATING AND DRINKING PLACES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#				***			-***			***	0.95
1980 MILES	*	#	1,166 ***				***		**	-**		#	#	0.83
	MAN+SVC	#					***			-***			***	0.95
1980 >2LN	*	#	9,454 ***	-***			**					#	#	0.75
MILES	MAN+SVC	#					***			-***			***	0.94

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	9 ***	-*			***	**	*	-***	#	#	0.78
	MAN+SVC	#		-*			***			-***	-***	***	0.93
1980 >2LN	*	#	69 ***	-***			*			-***	#	#	0.69
MILES	MAN+SVC	#					***			-***	-***	***	0.92

SIC GROUP 32 : SIC CODES 57, 59 : FURNITURE AND MISC. RETAIL

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#			-**	**			-***		-***	***	0.89
1980 MILES	*	#	431 ***				***	*	**	-***	-***	#	#	0.76
	MAN+SVC	#				-**	***			-***		-***	***	0.89
1980 >2LN	*	#	3,300 ***	-***			*			-***		#	#	0.66
MILES	MAN+SVC	#				-***	***			-***		-***	***	0.89

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	7 ***				***	***	*	-***	#	#	0.76
	MAN+SVC	#	1 *				***	*		-***	-***	***	0.91
1980 >2LN	*	#	57 ***	-***			*			-***	#	#	0.66
MILES	MAN+SVC	#					**			-***	-***	***	0.91

NOTES :
= VARIABLE NOT INCLUDED IN REGRESSION
COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN
SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :
*** = 1% OR LESS
** = 5% OR LESS
* = 10% OR LESS

SIC GROUP 33 : SIC CODES 60 TO 65 : FINANCE, INSURANCE AND REAL ESTATE

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#	-*			***	*		-***		-***	***	0.89
1980 MILES	*	#	743 ***	-**			***	***		-***		#	#	0.73
	MAN+SVC	#	184 **	-*			***	**		-***		-***	***	0.89
1980 >2LN	*	#	5,908 ***	-***			**	**		-***		#	#	0.64
MILES	MAN+SVC	#					***	*		-***		-***	***	0.89

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	36 ***	-*			***	***		-***	#	#	0.76
	MAN+SVC	#	5 *				**	***		-***	-***	***	0.93
1980 >2LN	*	#	292 ***	-***				**		-***	#	#	0.67
MILES	MAN+SVC	#					*	**		-***	-***	***	0.93

SIC GROUP 34 : SIC CODE 70 : HOTELS AND LODGING

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#	-*		*		**		-***		-***	***	0.87
1980 MILES	*	#	294 ***	-**		**	**	***		-***		#	#	0.73
	MAN+SVC	#	60 **	-*		**		**		-***		-***	***	0.87
1980 >2LN	*	#	2,417 ***	-***		***		**		-***		#	#	0.65
MILES	MAN+SVC	#		-**		**		**		-***		-***	***	0.87

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	3 ***	-**		**		***		-***	#	#	0.72
	MAN+SVC	#	1 ***			***		***		-***	-***	***	0.85
1980 >2LN	*	#	25 ***	-***		***		**		-***	#	#	0.64
MILES	MAN+SVC	#		-**		**		**		-***	-***	***	0.84

NOTES :

\# = VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 35 : SIC GROUP 72 : PERSONAL SERVICES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#			-**	***	-*				**	***	0.65
1980 MILES	*	#	47 ***			-*	**			*		#	#	0.61
	MAN+SVC	#				-**	***	-*				**		0.65
1980 >2LN	*	#	303 ***			-*	**	-*		**		#	#	0.56
MILES	MAN+SVC	#				-**	***	-*				*		0.65

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	0.33 ***			-**	*				#	#	0.40
	MAN+SVC	#				-**	*				*		0.42
1980 >2LN	*	#				-**				*	#	#	0.36
MILES	MAN+SVC	#				-***	*				*		0.42

SIC GROUP 36 : SIC CODE 73 : BUSINESS SERVICES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#		-*					-***			***	0.98
1980 MILES	*	#	1,866 ***					*	**			#	#	0.79
	MAN+SVC	#								-***			***	0.98
1980 >2LN	*	#	15,376 ***	-***								#	#	0.72
MILES	MAN+SVC	#			-*					-***			***	0.98

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	32 ***		-*			**	**	-*	#	#	0.81
	MAN+SVC	#						**		-***		***	0.96
1980 >2LN	*	#	264 ***	-***		**					#	#	0.73
MILES	MAN+SVC	#						**		-***		***	0.96

NOTES :

\# = VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 37 : SIC CODE 76 : MISC. REPAIR SERVICES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#				-**						***	0.87
1980 MILES	*	#	70 ***						**			#	#	0.77
	MAN+SVC	#					-**						***	0.87
1980 >2LN	*	#	573 ***	-***								#	#	0.71
MILES	MAN+SVC	#					-**						***	0.87

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	2 ***						***		#	#	0.80
	MAN+SVC	#				-*	-***		*			***	0.93
1980 >2LN	*	#	15 ***	-***			-*				#	#	0.77
MILES	MAN+SVC	#	2 **				-***					***	0.94

SIC GROUP 38 : SIC CODES 78,79 : MOTION PICTURES AND AMUSEMENT SERVICES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#							-***	**	-***	***	0.94
1980 MILES	*	#	255 ***				**	**	*	-***		#	#	0.80
	MAN+SVC	#					*			-***	**	-***	***	0.94
1980 >2LN	*	#	2,058 ***	-***						-***	***	#	#	0.75
MILES	MAN+SVC	#								-***	**	-***	***	0.94

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	6 ***				**	***	**	-***	#	#	0.77
	MAN+SVC	#	2 ***					**		-***	-***	***	0.91
1980 >2LN	*	#	50 ***	-***		**		**		-***	#	#	0.69
MILES	MAN+SVC	#						**		-***	-***	***	0.90

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 39 : SIC CODE 80 : HEALTH SERVICES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#				*						***	0.97
1980 MILES	*	#	1,540 ***				**	*	**		-*	#	#	0.84
	MAN+SVC	#					*						***	0.97
1980 >2LN MILES	*	#	12,386 ***	-***		*						#	#	0.77
	MAN+SVC	#					*						***	0.97

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	55 ***					**	**		#	#	0.83
	MAN+SVC	#						**		-***	-***	***	0.99
1980 >2LN MILES	*	#	454 ***	-***							#	#	0.76
	MAN+SVC	#						**		-***	-***	***	0.99

SIC GROUP 40 : SIC CODE 81 : LEGAL SERVICES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#							-***		-***	***	0.94
1980 MILES	*	#	194 ***		-*			***	**	-***	-*	#	#	0.81
	MAN+SVC	#	39 ***					*		-***		-***	***	0.95
1980 >2LN MILES	*	#	1,539 ***	-***		*				-***		#	#	0.71
	MAN+SVC	#								-***		-***	***	0.94

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	8 ***					***	**	-***	#	#	0.79
	MAN+SVC	#	2 ***			**		**		-***	-***	***	0.94
1980 >2LN MILES	*	#	65 ***	-***		**		*		-***	#	#	0.71
	MAN+SVC	#	7 *			*		*		-***	-***	***	0.93

NOTES :

\# = VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 41 : SIC CODES 82,92,93 : EDUCATION, LOCAL AND STATE GOVERNMENT EMPLOYEES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#		***		***			-**	**		***	0.50
1980 MILES	*	#	166 ***		**		***	**		-***	*	#	#	0.50
	MAN+SVC	#			**		***			-**	**		**	0.52
1980 >2LN	*	#	1,489 ***	-*	**		***	*		-***	**	#	#	0.51
MILES	MAN+SVC	#	827 *	*	**		***			-**	**		*	0.52

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	20 ***				***	**	**	-**	#	#	0.82
	MAN+SVC	#	4 *		*		***			-*	-***	***	0.91
1980 >2LN	*	#	169 ***	-***		**	***				#	#	0.78
MILES	MAN+SVC	#	27 *		*		***			-*	-**	***	0.91

SIC GROUP 42 : SIC CODE 83 : SOCIAL SERVICES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#				***	-*				-***	***	0.82
1980 MILES	*	#	174 ***				***			-*		#	#	0.73
	MAN+SVC	#				-**	***					-***	***	0.82
1980 >2LN	*	#	1,410 ***	-**			***					#	#	0.69
MILES	MAN+SVC	#				-**	***	-*				-***	***	0.82

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAIRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	2 ***				***			-***	#	#	0.76
	MAN+SVC	#	1 ***			-**	***				-***	***	0.83
1980 >2LN	*	#	19 ***	-***			***			-*	#	#	0.71
MILES	MAN+SVC	#				-**	***				-***	***	0.87

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

SIC GROUP 43 : SIC CODES 86 TO 89 : MISCELLANEUOS SERVICES

DEPENDENT VARIABLE : SECTOR EMPLOYMENT CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	WAGES	MANEMP	SVCEMP	R**2
POOR	MFG + SVC		#				*	-**				**	-***	0.96
1980 MILES	*	#	(374)***					-**	-*		-**	#	#	0.81
	MAN+SVC	#					*	-*				**	-***	0.96
1980 >2LN	*	#	(3,097)***	***								#	#	0.74
MILES	MAN+SVC	#					*	-**				*	-***	0.96

DEPENDENT VARIABLE : SECTOR WAGE-INCOME CHANGE 1980-88 INDEPENDENT VARIABLES

ROAD VAR	AGGLOM VAR	COND	MILES	ELEC	WATER	APT	COLL	MSA	RECR	TAXRT	MANEMP	SVCEMP	R**2
1980 MILES	*	#	(10)***					-**	-**		#	#	0.78
	MAN+SVC	#				*		-*			***	-***	0.96
1980 >2LN	*	#	(79)***	***							#	#	0.72
MILES	MAN+SVC	#				*		-*			***	-***	0.96

NOTES :

= VARIABLE NOT INCLUDED IN REGRESSION

COEFFICIENT VALUES FOR SIGNIFICANT HIGHWAY VARIABLES ARE SHOWN

SIGNIFICANCE LEVEL AT WHICH PARAMETER WAS DIFFERENT FROM 0 :

*** = 1% OR LESS

** = 5% OR LESS

* = 10% OR LESS

COVER DESIGN BY ALDO GIORGINI